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AUGUST 1943

AIEE NATIONAL TECHNICAL MEETING, SALT LAKE CITY, UTAH, SEPTEMBER 2-4, 1943

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The Cover: This mine of the Utah Copper Company will be inspected in connection with the presentation of technical papers on mining and metallurgy at the forthcoming AIEE national technical meeting, to be held in Salt Lake City, Utah, September 2–4, 1943

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Planning for Things to Come

HAROLD S. OSBORNE
PRESIDENT AIEE 1942-43

Retiring President Osborne urges immediate planning to meet postwar engineering problems. The effective solution of these problems will require co-ordination with community and other planning. One problem of major importance is the greater unification of the engineering profession.

IT SEEMS CLEAR that at the close of this war we will find that many of the conditions of our life have been profoundly modified. Whatever it is that we are moving forward to, it will be in many respects quite different from the past. Under these conditions it is a sign that society is healthy if attention is directed to the future more than to the past. Rather than thinking of the postwar period in terms of a return to normalcy or to the "good old days," we shall do well to think in terms of planning for the new things to come.

Some may think that there is too much talk now about postwar planning. However, a great deal of thought will be necessary if we are to make suitable and adequate postwar plans. There is a great deal of groundwork to be done in advance if we are to have suitable plans available for action when the time for action comes in each of the many aspects of the postwar problems. If this discussion serves to stimulate constructive thought on the subject, it will be justified and time well spent.

OUR FIRST RESPONSIBILITY: THE PLAN FOR VICTORY

Let us first pause a moment in our thinking to do homage to the men in the fighting forces, who are now carrying out the one plan which it is absolutely essential shall succeed—the plan for victory. If that plan should not succeed we would have no occasion to make any other plans. In that tragic event the course of things to come would be determined for us, by the Axis dictators. Keeping this fact ever in mind should insure that we have the proper perspective. Our first responsibility is that of bringing the greatest possible effort to bear to help carry out the great plan of victory. For the duration this will remain our first responsibility. Whatever we do in postwar planning must not interfere with that.

ENGINEERING PLANNING: ONE PART OF THE BROAD POSTVICTORY PROBLEM

Planning for the postwar world covers the entire range of social problems and human activities. It involves, in many diverse fields, problems of great complexity and uncertainty in which the best efforts of man and of his social institutions will be necessary to obtain success or even to avoid catastrophe. For example, we must plan to maintain world peace—a necessity secondary in its urgency only to the plan for victory. That is the plan which we did not make successfully 25 years ago. There is planning for world reconstruction, and planning for the economic development of this country and of other countries. These matters are of great importance in shaping our future. We all have, as citizens and in other capacities, responsibilities in these matters which are fundamental. Mentioning these fields of planning merely by title is not to imply that we can dismiss them lightly. But, we cannot, in one discussion, consider all of the problems of the world. I propose that we direct our thoughts to some phases of planning for the future which are most directly related to our own engineering work and to the profession of engineering of which we form a part.

PLAN THE PLANNING

Each of us has a direct concern in the plans for the future of the organization in which his professional work is done. Many of us, whether associated with the educational, manufacturing, public utility, or other branch of the profession, are engaged to a greater or less degree in such planning. I would not undertake to indicate what the scope of that planning work should be in any specific organization. Indeed, it is my conviction that the proper scope of work is vastly different in the different organizations represented by our membership. There appear, however, to be general principles underlying this work.

At the start I believe we should plan the planning. Some of us may have received the impression, from some of the current talk about planning, that some work is possibly being done too soon. It is a fundamental of sound engineering that plans must be available for use at the time they are needed. But it is unavoidable in these days of rapid change that plans which are made before they are needed necessarily involve some waste effort. If we plan the planning we should thereby determine which planning jobs should come first, put first things first, and avoid the waste effort which might result from a less careful scheduling of planning.

We speak of this activity as postwar planning. That may be a misnomer. For the construction of plant or the manufacture of products, V-day is the day when materials and manpower become available for such purposes. For engineering education, V-day is the day

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Essential substance of the presidential address delivered at the annual meeting during the AIEE national technical meeting, Cleveland, Ohio, June 21–25, 1943.

when students, out of uniform, again flock to the universities. These V-days may not be the same and may not be the time at which the peace treaty is signed.

BASIC REQUIREMENTS OF PLANNING

All the discussions of planning recognize the basic requirement that the postwar activities in the aggregate shall maintain a high level of employment and production. There are differences in the methods proposed to bring this about. This, you may recall, was the subject of Past President David C. Prince's presidential address[1] a year ago, and has been ably presented by him and others on various platforms during the past year, as representatives of the Committee on Economic Development.

Another basic requirement for many industries is that of re-establishing the practice of meeting the service requirements of our customers. This bulks large in the postwar planning of many utilities. For example, in the telephone industry we believe that if general business conditions are at least fair, this necessity will largely dominate our early postwar activities, since the construction of large amounts of plant will be necessary to give all the service demanded, including the locked-up demand of people who couldn't get service during the war, and to restore the quality of service which we like to give our customers in peacetime.

A general consideration in postwar planning is the resumption or establishment of programs of betterment. This also is important in the postwar thinking of utility engineers as large quantities of construction of new types of plant replacing older types, desirable for the improvement of service and for economies, have necessarily been postponed during the war.

The war experiences have developed a great deal which is new, and our planning must take account of the possible application of some of this in the postwar period. This, of course, applies pre-eminently in the applications of science to the development of new materials, new instrumentalities, and new technical processes. Its application is broader, however, than material things. It includes experience in getting along under difficult conditions, in doing the best with what we have, in meeting heavy overloads, in cutting out some of the frills in our products or services and finding out how to get along in the best possible way without them. All of this totals up to a grist of experiences of which we must take advantage, each in his own field, if we do a thoroughgoing job of postwar planning.

To plan effectively for the future we must recognize also that continuing rapid change will probably be a characteristic of the era in which we live. This recognition appears repeatedly in the current discussions of planning. For example, it seems to be the keynote of an analysis of the postwar problems of the engineering colleges presented by Doctor William E. Wickenden last October to a group of administrators of engineering colleges and universities.[2] In his inimitable language, Doctor Wickenden points out that after the war we shall face a radically altered social and economic structure in which this country will have irrevocably assumed world responsibilities. Technical education, broadly defined, will become the main stem of American higher education, he believes, and as such will have to carry a much larger share than heretofore of the cultural responsibility of American life. To meet their responsibilities, educational institutions will have to shed many ideas of the past. For example, there may be increased emphasis on differentiating undergraduate work along the lines of research and development, construction and operation, and management and business relations, with reduced emphasis on the classical divisions of engineering into technical branches—civil, mechanical, electrical, and so on. These comments of Doctor Wickenden illustrate for education a need that holds in all branches of the profession.

These basic considerations suggest a breadth in the scope of postwar planning which has not always been reflected in the discussions on this subject. Adequate postwar planning involves not only drawing blueprints of the shape of things to come, perhaps under a variety of assumed conditions; it involves, also, preparing ourselves to handle effectively the volume of work and the new problems which will come upon us at that time.

For example, I have mentioned that the postwar plans for the telephone industry indicate the construction of large amounts of plant. It may be too early now to draw up detailed plans for the specific projects of that program. However, to carry out that program effectively, a large amount of preparatory work should be done in advance. This includes general fundamental engineering plans taking into account the probable developments in demand for service and the availability of new instrumentalities; a critical study of past and current engineering practices to see whether the experience of carrying heavy service overloads during wartime may not suggest some modifications in practice which can be carried forward advantageously into the postwar period; the training of engineering and other personnel in new techniques; getting into good shape any additional records required for the effective conduct of the postwar program; and a careful consideration of the long-term effect of underlying trends and of new possibilities for service brought about by developments in service demands and by new instrumentalities.

I mention the telephone merely because of my familiarity with telephone problems. This approach, seems to me to be illustrative of a general principle. If we think of postwar planning broadly, there is much preparatory work to be done before we get to the blueprint stage, and much of this comes in the class of first things to be done first.

COMMUNITY PLANNING

When one engages in postwar planning for his own organization, it comes to his attention forcibly and repeatedly that his planning is dependent in part on the planning of others. This reaction of planning in the broader fields applies in greater or less degree to almost the entire range of postwar planning activities. Though it is not feasible to discuss this large field now, it seems desirable, nevertheless, to consider the relation between planning for our own organizations and planning for the next larger social unit—the community.

The fact is that the organizations for which we are planning are in each case a part of a community and our futures are tied up inextricably with the futures of the communities as a whole. Perhaps the most extreme case of this interdependence is the public utility. Such a utility, whether power, gas, or communication, is giving service to a community. Its property consists almost wholly of fixed plant located not only in the community but in specific localities throughout the community. Anything which tends to increase the development of the community, anything which modifies the distribution of people throughout the community, anything which tends to prevent wasteful and unsuccessful attempts at the development of localities or which stabilizes conditions in existing neighborhoods, is of most direct concern to it. Other industries, although representing a less extreme case, are in a somewhat similar position. Every industry has a direct stake in the development of the community because of its effect upon the ability of workers to obtain satisfactory and economical living conditions and on the ease of doing business, and because of the impact of the cost of community government.

In the early stages of the development of American communities it was customary to take for granted the continued rapid expansion and the prosperity of communities, particularly of metropolitan areas. This faith was to a large extent justified. Now, however, with a tendency for the total population of the country to stabilize, and with many influences tending to shift industry and to accelerate the migration of populations, we can no longer take for granted such continued expansion and prosperity of all communities. For example, Doctor Philip Hauser, assistant director of the Census, has published recently an interesting analysis and prophecy regarding the future of 135 metropolitan areas in the United States.[3] He prophesies that about 40 per cent of these will probably retain an above-average wartime growth; that about 30 per cent will lose population, or at best become stabilized; and that the other 30 per cent are in intermediate situations more difficult to analyze. The fact that at least one expert has reached such conclusions illustrates the importance of present trends in community planning.

Community planning dealt first with the future expansion of communities into undeveloped areas, including, in some notable cases, the laying out of entirely new cities. As our communities have grown older, increasing importance has been attached to stabilizing conditions and to the rehabilitation of such of the older parts of the community as have become blighted. Then came the war, with a devastating effect in accelerating changes of industry and the relocation of populations to a degree which normally would have taken many years to bring about. In the haste of war preparations some good planning work was done in the locating of industries and housing developments, and much was done with poor planning or none at all.

We look forward now to a postwar period which will be second only to the early war period in the intensity and extent of shifts of industries and populations as conversion is made from war production to peace production. How will these changes affect the individual community? What will be the industrial activity of the community and what population will be supported by it? What would be the physical development of a community to provide best for this population and for the industries and businesses with which they will be associated? These questions are in the forefront of community planning problems today.

In my judgment community planning, generally speaking, has been only partially successful in the past. This has been due largely to lack of popular support, arising from a lack of appreciation on the part of those most directly concerned of the importance of this subject to them in their own future planning. If we are to have an adequate quantity and quality of community planning there must be a general understanding of its importance.

An important part of community-planning activities is usually focused in an official planning agency associated with the local government, designated as a city planning commission or a regional planning commission. However, such an official planning agency is only one of the groups which should interest themselves in community planning if it is to be fully effective. The co-operation of every citizen is necessary both for making adequate plans and for carrying them out. Many questions important in community planning, including those related to the future industrial development of the community, are beyond the power of the local government to answer. The carrying out of such plans is dependent on the activity of many groups concerned both inside and outside of the community government. The citizens must accept the plans which are best for the community as a whole.

For these reasons it seems clear that adequate community planning requires not only an official planning commission but also the sustained interest and action of groups of citizens acting through their various organizations. Such organizations may include Chambers of Commerce, service clubs, various civic organizations, and neighborhood organizations of property owners. Above all I should like to see the engineering groups in every community take the lead in establishing organizations of citizens who will concern themselves directly in planning the future of their communities.

U OF I
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GREATER UNIFICATION OF THE ENGINEERING PROFESSION

It is obvious that participation by engineers in the planning of a community can be done best if all the engineers of the community work together as a united group rather than as a number of separate engineering groups. In going about the country during the past year visiting Sections of the AIEE, I have been impressed by the close co-operation in many localities between engineers of all categories, including the sections of the great engineering societies and other groups. I have a list of about 75 local and regional societies and clubs which are endeavoring to bring about in their localities a co-ordinated activity of all engineers. These organizations are increasing in number and growing in effectiveness. They take an active part in community affairs, and represent engineers as a whole before the people.

Frequently, in my visits to Institute Sections, the Section officers have asked how soon the national engineering organizations will get together in a similar way. I believe this question, more often than any other, is in the minds of our members as they think of plans for the future of our own organization.

Let us review briefly what the situation is with reference to the organization of engineers in this country. I think we can say without boasting that the great technical engineering societies have done and are doing a magnificent job. The four founder societies together have a membership of about 67,000 (not excluding duplications) and are still the largest engineering societies in the country among the dozens which have been organized. Add to these about half a dozen other large technical engineering societies and there is a total membership of about 100,000, a membership which has grown steadily through the years except during the depth of the depression.

The national organizations of these societies are devoted largely to technical and educational work. Their members are the backbone of the 75 local and regional engineering organizations, and through these organizations do a great deal of civic and community work.

The national engineering societies are co-operating directly and informally on many questions and also through a number of co-operative organizations. The United Engineering Trustees, on behalf of the four founder societies, owns and operates the engineering building in New York, maintains an engineering library, and administers for the advancement of research the funds of the Engineering Foundation. The Engineers' Council for Professional Development, a relatively new organization, has a fine record of progress toward its objective of higher professional standards of education and practice, including able work in the field of selection and training of engineers, and in the certification of courses of instruction in engineering colleges. In that organization eight national engineering societies co-operate. There is a joint conference of the presidents and secretaries of five of the engineering societies. There are several joint boards of award, each representing four or five national engineering societies. The American Standards Association was launched by the united efforts of five engineering societies and has now grown to such a stature that the professional societies have a minority although still a very important voice in the conduct of its affairs.

In view of this splendid record of accomplishment and co-operation, some may ask whether anything is lacking in the organization of the engineering societies. An answer to this question, and one which I believe represents the opinion of a majority of engineers, is that the engineering profession needs, and also the country needs, a central agency which can represent the entire engineering profession in matters of public concern. This point of view has been ably expressed by previous presidents of the Institute and by numerous distinguished engineers speaking before this Institute and other engineering societies.

On the one hand there is a fading of the boundaries that once separated more definitely than now the civil, mechanical, mining, and electrical engineering fields. The application of fundamental scientific knowledge and the growth of arts based on engineering are to an increasing extent breaking across these boundaries. A large number of the men in the top grades of membership in the founder societies need no longer be considered mechanical engineers, civil engineers, or electrical engineers. They are *engineers*, the scope of whose responsibilities cuts across the boundaries of these classifications.

Furthermore, public and semipublic questions involve important engineering considerations to an increasing extent—considerations which also cut across the boundaries of these classifications. There is a need for united consideration by the engineering profession as a whole of many questions, particularly in giving advice to the numerous agencies of government on the engineering phases of public questions.

The four founder societies had for a number of years an organization intended to fill this need at least in part—the American Engineering Council. Associated with the founder societies in this project were a number of local and regional organizations. The American Engineering Council was discontinued at the end of 1940. I believe that the reasons why the Council was not wholly successful are technical and organizational in character rather than related to the fundamental soundness of the purposes of the organization.

The professions of medicine and law, as has been said often and well, are far ahead of the engineers in respect to organization. The American Medical Association and the American Bar Association, representing smaller groups than the engineers, are effective media through which the special knowledge of medical men and lawyers is brought to bear on public questions.

But great public engineering works are constructed in this country and the group opinion of the body of engineers is not even expressed.

At least two attempts, not backed by the founder societies, have been made to build up engineering organizations which would do work for the benefit of engineers of all technical classifications. The American Association of Engineers was chartered in 1915 "to promote the social and economic welfare of the engineer, to stimulate public service in the profession, and to encourage and develop the efficiency of the engineer." It expected to enroll 100,000 members. Its membership rose by 1921 to 28,000. Its present membership is 5,000. More recently, in 1934, the National Society of Professional Engineers was organized with somewhat similar objectives. Membership in this society is open to all engineers registered under the laws in their respective states. This society has a membership at the present time of about 8,000.

Both of these organizations have criticized the technical engineering societies. We have not, it is said, measured up to our opportunities in the advancement and service of the profession. We exhibit "smug complacence in a circumscribed sphere of self-aggrandizement and, above all, failure to manifest concern for and participate in the affairs of community, state and nation as organized units of society." We represent an old order which is passing.

I think we should take these criticisms with a grain of salt but also in a sober spirit of reflection and self-examination. We not only have criticism from those outside, but also many inside the societies feel that the engineering profession is not organized to take the part in public affairs which it should. There is also the feeling of many that engineering is not recognized as a profession as fully as it should be. People still speak of the three learned professions, divinity, law, and medicine. One must look far in the unabridged dictionaries to find engineering among the examples which are given of professions. These criticisms seem to me all to be related.

I believe that the great national engineering societies have an important social responsibility, both to their profession and to their country, to plan what is the best form of organization of the engineering profession. The joint conference committee, consisting of the presidents and secretaries of five national engineering societies, voted at its last meeting to invite the constituent societies each to appoint members to a joint committee for the study of the problem and the presentation of recommendations as to the most desirable form of organization.

I hope this committee will be appointed and will recognize their assignment as a planning job which is not only important but difficult. It has been the subject of much study in the past and, apparently, we have not come to the right answer. Eleven years ago this question was studied by a joint committee of the four founder societies. That committee agreed that a central administrative agency should be set up which should eventually supervise as many joint activities of the societies as feasible. But the committee was unable to propose a form of organization which would find general acceptance. The complication of the problem is well brought out by an interesting report made in 1941 by a committee of the Cincinnati Section of this Institute which pointed out that the problem as a whole involves three groups of engineering societies—the great national societies devoted primarily to technical work, engineering organizations concerned primarily with the education, legal qualification, and professional development of the engineer, and the local and regional engineering societies.

Basic to any proposal for the establishment of a central co-ordinating or administrative agency is the purpose to be achieved by such central organization. It seems to me there may be many purposes. Surely, the area in which co-operative action between the present engineering organizations may be beneficial is not wholly covered by the activities of our present co-operative enterprises. There are a number of cases, in this country and in other countries, of collaboration between scientific societies or engineering societies as evidence.

While many purposes may be served by a centralized agency for the engineering profession, it is my view that the plans should be built about a central purpose which is professional in character. Many organizations are directed primarily to the service of their members. These fill a necessary and useful purpose but their aim is not necessarily a professional aim. The term "profession" implies a stewardship. The thing which distinguishes a professional man, as Doctor Bush has said so well,[4] is his use of special knowledge for ministry to the people. While engineers come from many specialized branches of the main stem of engineering knowledge and represent groups whose interests are by no means identical, they find professional unity through such ministry. I believe that failure fully to recognize this fact has been an important reason for the imperfect success of past organizations which have attempted to represent the engineering profession as a whole.

In making our plans for the future of the engineering profession, let us aim for a unity which will make possible the highest form of professional expression. It is through emphasis on ministry to the people rather than on direct service to its members that such an engineering organization may achieve the highest professional standing. And in doing this it will indirectly help all engineers through the increased appreciation on the part of everyone of the greatness of the engineering profession.

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Ultrashort Electromagnetic Waves

V—Radiation (Continued)

ANDREW ALFORD
MEMBER AIEE

This article is the concluding portion of the fifth lecture in the series on ultrashort waves sponsored by the basic science group of the AIEE New York Section. In the design of radiators or antennas for ultrashort waves a complete solution of Maxwell's field equations usually is not practicable, and engineering approximations are resorted to. The first installment (July issue) presented a method to be used when the distribution of current and charge over the radiator surface is known. This concluding portion presents a second method for the calculation of the field in space on the basis of known field distribution in the immediate vicinity of the radiator.

IN the first half of this article a method was developed which is used to calculate the radiation fields of radiators with a known current distribution. This method could be used to calculate the radiation fields of such radiators as an electromagnetic horn or a metal box with an aperture if the current distribution along the inner and outer surfaces of such a radiator were known. Usually such application of method 1 is at least very inconvenient. To convince ourselves of this fact we need only contemplate the integration over the inner surface of a metal box with an aperture. The difficulty is not so much that the integrals are apt to become unmanageable as that the current distribution may not be known with adequate accuracy. For example, in the case of the metal box with the aperture, the current distribution inside the box may be completely unknown, and the only quantity which could be measured with reasonable ease is the electric field in the immediate vicinity of the opening.

METHOD 2

It would be very convenient if from such relatively meager knowledge it were possible to calculate the components of H and E at all other points in space. It happens that this may be done with some limitation with the aid of the so-called *equivalence principle* together with method 1.

In order to explain the equivalence principle, it will be convenient to focus our attention on the radiator of Figure 12. This is a typical problem, and we are not in danger of deriving results applicable to just one particular case. Let us begin by assuming that both H and E are known at every point along the aperture which we shall call surface S. The problem is to calculate H and E at a point $P(x, y, z)$ in the surrounding space. We may start by asking ourselves the following question: Is it possible to devise a distribution of currents and charges, the field of which would cancel precisely the actual field? For, if this were possible, we could use method 1 to calculate H and E produced by the distribution of currents and charges, and the values of H and E found in this manner would be exactly equal to the actual field except for a reversal in sign.

The problem of devising such a current and charge distribution has more than one solution. Any one of these possible solutions would serve our purpose, provided, of course, that the expressions for current and charge density in terms of H and E are relatively simple. This current and charge distribution need not be physically realizable. On the contrary, it may be as impracticable as we wish, as long as we are able to calculate the field which it produces, and the field is equal and opposite to the actual field. Since a volume distribution of current is much more complicated than a very thin current sheet, we shall attempt to construct a current sheet.

Let the surface of the current sheet be surface S which closes the aperture of the wave guide in Figure 12. Let i be current density per unit length measured at right angles to the lines of flow. Let σ be the electric-charge density per unit of area of surface S, and let E and H be the actual undisturbed electric and magnetic fields along surface S. The values of E and H will be assumed to be known at every point along surface S.

It will be convenient to resolve H into two components H_n and H_p. H_n is normal to S and H_p is parallel to S. The direction of H_p will be such that H_p, H_n and H all lie in the same plane, which is normal to S. The electric field E will also be resolved into similar normal and parallel components, E_n and E_p.

Let us direct our attention to a small portion of surface S. Such an element of S is shown in Figure 13. In this figure, dotted line AB is drawn parallel to H_p.

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Points C and D on line AB are any two points separated by a very short distance l. Let a current of surface density $\boldsymbol{i}$ flow across line AB, and let the direction of the lines of flow between points C and D be perpendicular to CD. The total current which flows across CD is then il. This current will produce a magnetic field which, in the immediate vicinity of surface S, will be parallel to the surface. Figure 14 shows the state of affairs in the plane which passes through line AB and which is perpendicular to surface S. This plane would be at right angles to the paper in Figure 13, and its trace is line AB. In Figure 14 the current is flowing toward the reader. The contour $abcd$ indicates a typical line of force of magnetic field $\boldsymbol{h}$ of current il. If we take a unit magnetic charge around the contour $abcd$, we shall do work which approaches $2l \cdot h$ when distances cb and ad are made very small. This same work must be equal to $4\pi/c$ times the current. It follows that

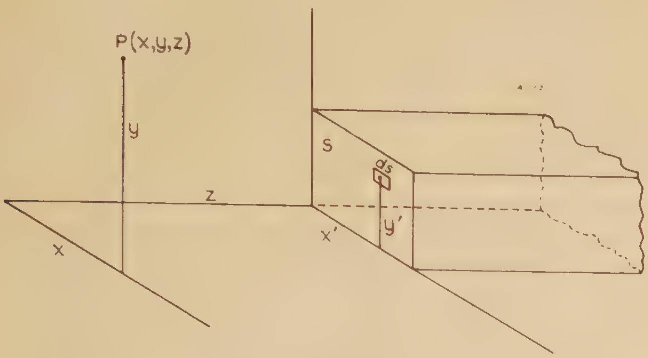


Figure 12. Radiating end of a rectangular wave guide

$$2hl = \frac{4\pi}{c}\,(il), \qquad h = \frac{2\pi}{c}\,i \tag{66}$$

From this it is clear that, if we make the magnitude of current density $i = (c/2\pi)H_p$, and the direction of $\boldsymbol{i}$ perpendicular to H_p at every point along S, the magnetic field produced by such current sheet will be $+H_p$ on one side of surface S and $-H_p$ on the other side of S. This current sheet would cancel completely the H_p component of $\boldsymbol{H}$ on one side of S.

Since, in general, H_p is not constant over surface S, the value of $\boldsymbol{i}$ will also vary from point to point. The value of $\boldsymbol{i}$ will vary even in the direction of the lines of flow. For example, the current density along $C'D'$ may be greater than along CD, even when the direction of $\boldsymbol{i}$ and therefore of the lines of flow remains the same, that is, even when the lines of flow neither converge nor diverge. In a physically realizable system this could happen only if there were a variable surface charge density σ related to the current by the equation of continuity

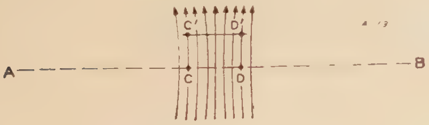


Figure 13. Lines of current flow

$$\frac{\partial i_x}{\partial x} + \frac{\partial i_y}{\partial y} + \frac{\partial \sigma}{\partial t} = 0 \tag{67}$$

If we choose the co-ordinates so that x is parallel to the lines of flow, then $\partial i_y/\partial y = 0$, $i_x = i$ and $(\partial i/\partial x) + (\partial \sigma/\partial t) = 0$. If our current distribution is to behave in accordance with the continuity equation, we must have σ which is very closely related to H_p. Since $i = (c/2\pi)H_p$ we have

$$\frac{c}{2\pi}\,\frac{\partial H_p}{\partial x} + \frac{\partial \sigma}{\partial t} = 0 \tag{68}$$

Surface density σ is always accompanied by an electric field e which is normal to the surface. The magnitude of this normal field is $e = 2\pi\sigma$. Half of the lines of this electric field terminate on one side of the surface, and the remaining half on the other side of the surface.

If we substitute $e = 2\pi\sigma$ into equation 68, we find that

$$\frac{\partial H_p}{\partial x} = -\frac{1}{c}\,\frac{\partial e}{\partial t} \tag{69}$$

In an electromagnetic field, $\boldsymbol{H}$ and $\boldsymbol{E}$ are not independent but are such that

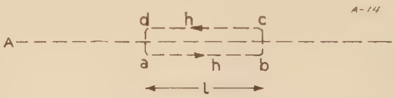
$$\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y} = \frac{1}{c}\,\frac{\partial E_z}{\partial t}, \text{ and so forth}$$

If the co-ordinates are such that x, as before, is along the lines of flow of $\boldsymbol{i}$, z is perpendicular to S, and y is in the direction of positive H_p then $E_z = E_n$ and

$$\frac{\partial H_p}{\partial x} = \frac{1}{c}\,\frac{\partial E_n}{\partial t} \tag{70}$$

By comparing equations 70 and 69, we see that $e = -E_n$ except for a term which is independent of time and which can be put equal to zero without further worry when we are interested in alternating fields. The sign of e depends on the direction of $\boldsymbol{i}$. When $\boldsymbol{i}$ is in the direction of positive x, $\partial i/\partial x$ is positive, σ is negative, and $\boldsymbol{h}$ is negative on the positive z side of S. On this same side of S, field e is also negative. It follows that, when the direction of $\boldsymbol{i}$ is such that its magnetic field $\boldsymbol{h}$ cancels H_p, the charge density accompanying $\boldsymbol{i}$ produces electric field $\boldsymbol{e}$ which cancels E_n on the same side of S.

Figure 14. Magnetic field of current in Figure 13



So far, we have accomplished only about one half of what we set out to do. Our object was to devise a distribution of currents which would cancel all components of the actual field. We have obtained a distribution of electric-current density $\boldsymbol{i}$ and of the accompanying electric-charge density σ which cancel H_p and E_n in the immediate vicinity and on one side of surface S. H_n and E_p still remain. It is clearly necessary to superimpose on surface S something in addition to $\boldsymbol{i}$ and σ to take care of H_n and E_p. H_n can terminate only on magnetic poles. We have no choice: we must add magnetic-surface density $\sigma^* = (1/2\pi)H_n$. This magnetic-charge density, like H_n, is a function of time, and $\partial\sigma^*/\partial t \neq 0$. If the magnetic charges are to be confined to surface S, and their sum total is to remain invariant, that is, if these charges are not to disappear and reappear, there must be a "magnetic current" of density $\boldsymbol{i}^*$ which is related to σ^* by the equation of continuity

$$\frac{\partial i_x^*}{\partial x} + \frac{\partial i_y^*}{\partial y} + \frac{\partial \sigma^*}{\partial t} = 0 \tag{71}$$

If the direction of x coincides with that of $\boldsymbol{i}^*$, then $i_x^* = i^*$, $i_y = 0$ and

$$\frac{\partial i^*}{\partial x} + \frac{\partial \sigma^*}{\partial t} = 0$$

but since $\sigma^* = (1/2\pi)H_n$,

$$\frac{\partial i^*}{\partial x} + \frac{1}{2\pi}\frac{\partial H_n}{\partial t} = 0 \tag{72}$$

We may compare this equation with the general relation a between $\boldsymbol{E}$ and $\boldsymbol{H}$ which, in rectangular co-ordinates, is

$$\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y} = -\frac{1}{c}\frac{\partial H_z}{\partial t}, \text{ and so forth} \tag{a}$$

If the direction of y is parallel to E_p, and z is perpendicular to S, $E_x = 0$, $E_y = E_p$, and $H_z = H_n$. Hence

$$\frac{\partial E_p}{\partial x} = -\frac{1}{c}\frac{\partial H_n}{\partial t} \tag{73}$$

Equations 73 and 72 become identical if $cE_p = 2\pi i^*$, and $\boldsymbol{i}^*$ is perpendicular to E_p so that the directions of x in equations 73 and 72 coincide.

We shall assume that the magnetic current produces an electric field which satisfies an exact analogue of Biot-Savart's law for electric current, except that in the magnetic case we shall take $\boldsymbol{E}$ as counterclockwise when H in the electric case is clockwise. (We do not really need any physical justification for this assumption, provided it is used only to find a solution of Maxwell's equations a, b, c, d which satisfies the assumed boundary conditions. Such use of this assumption would not differ in principle from the familiar use of the assumption that $y = e^{j\alpha x}$ when solving the differential equation $d^2y/dx^2 + a^2y = 0$.) The Biot-Savart law for magnetic current can be advocated on the following purely physical grounds: if a displacement current $\partial \boldsymbol{E}/\partial t$ can produce a magnetic field just as an electric conduction current does, then why should not a magnetic conduction current produce an electric field just as a magnetic displacement current $\partial \boldsymbol{H}/\partial t$ does? From this assumption it follows at once that the work involved in carrying a unit electric charge around magnetic current (i^*l) is $4\pi(i^*l)$. By applying the reasoning which was used in connection with Figure 14, we find that $2lE_p = c \cdot 4\pi(i^*l)$, and hence $E_p = 2\pi c i^*$ in Gaussian units. The electric field of $\boldsymbol{i}^*$ will now cancel E_p when the field of σ^* cancels H_n. Thus we arrive at the following result: an electric-current sheet of density $i = (c/2\pi)H_p$ and with lines of flow perpendicular to H_p produces a magnetic field which exactly cancels the parallel component of the actual $\boldsymbol{H}$ on one side and in the vicinity of S.

The electric charge $\sigma = (1/2\pi)E_n$ produces an electric field which cancels the normal component of $\boldsymbol{E}$.

Magnetic charge $\sigma^* = (1/2\pi)H_n$ cancels the normal component of $\boldsymbol{H}$. Finally, the magnetic-current sheet of density $i^* = (1/2\pi c)E_p$ cancels the parallel component of $\boldsymbol{E}$.

In addition, $\boldsymbol{i}$ and σ as well as $\boldsymbol{i}^*$ and σ^* satisfy the equations of continuity.

We shall now go back to the wave guide of Figure 12. If the aperture of the guide is closed by a surface S which carries currents $\boldsymbol{i}$ and $\boldsymbol{i}^*$ and charges σ and σ^* as already defined, there will be neither a magnetic nor an electric field just outside S. *If there are no currents on the outer metal surfaces of the guide*, there will be no field anywhere in space. The current and charge distributions along S will have produced an equal and opposite field to that of the waves emerging through the aperture.

In order to find the original field at $P(x, y, z)$, we need only to calculate the field of our currents and charges on S and then reverse the sign.

The magnetic field of current density $\boldsymbol{i}$ is found directly from equations 17 and 18 of method 1.

$$\boldsymbol{H} = \text{curl } \boldsymbol{A}, \qquad \boldsymbol{A} = \frac{1}{c}\iint_S \frac{[\boldsymbol{i}]}{r}\, dS \tag{74}$$

The electric field of electric-current density $\boldsymbol{i}$ and electric-charge density σ is given by equations 27, 19.

$$\boldsymbol{E} = -\frac{1}{c}\frac{\partial \boldsymbol{A}}{\partial t} - \text{grad } V, \qquad V = \iint_S \frac{[\sigma]}{r}\, dS \tag{75}$$

Since the electric field $\boldsymbol{E}$ of magnetic current $\boldsymbol{i}^*$ was assumed to be in accordance with the Biot-Savart law except for the minus sign

$$\boldsymbol{E}_{i^*} = -\text{curl } \boldsymbol{A}^*, \qquad \boldsymbol{A}^* = c\iint_S \frac{[\boldsymbol{i}^*]}{r}\, dS \tag{76}$$

Since the magnetic field of a magnetic charge is in accordance with Coulomb's law, we may apply the same reasoning which was used to obtain the electric field of electric charges to calculate the magnetic field of magnetic charges. The result is

$$\boldsymbol{H}_{\sigma^*} = -\text{grad } V^*, \qquad V^* = \iint_S \frac{[\sigma^*]}{r}\, dS \tag{77}$$

As in the electric case, this is not the total field but only the part produced by the magnetic charges. There is another part which comes about as follows: Magnetic-current density $\boldsymbol{i}^*$ produces electric field $\boldsymbol{E}_{i^*}$ which is given by equation 74. This electric field $\boldsymbol{E}_{i^*}$ results in displacement current $\partial E_{i*}/\partial t$. The magnetic field of this displacement current has not yet been taken into account. The relation between a displacement current and its magnetic field is

$$\text{curl } \boldsymbol{H} = \frac{1}{c}\frac{\partial \boldsymbol{E}_{i*}}{\partial t}$$

Since

$$\boldsymbol{E}_{i*} = -\text{curl } \boldsymbol{A}^*$$

we have

$$\text{curl } \boldsymbol{H} = \text{curl}\left(-\frac{1}{c}\frac{\partial \boldsymbol{A}^*}{\partial t}\right) \qquad (74)$$

From which $\boldsymbol{H} = -1/c\ \partial \boldsymbol{A}^*/\partial t +$ (gradient of any vector). We already know from equation 77 what the second term on the right-hand side should be. The total $\boldsymbol{H}$ produced by the $\boldsymbol{i}^*$ and σ^* is therefore

$$\boldsymbol{H} = -\frac{1}{c}\frac{\partial \boldsymbol{A}^*}{\partial t} - \text{grad } V^* \qquad (78)$$

The total field produced by $\boldsymbol{i}$, $\boldsymbol{i}^*$, σ, and σ^* can now be obtained by simple addition.

Total $\boldsymbol{H} = \boldsymbol{H}$ from equation 74 $+ \boldsymbol{H}$ from equation 78
Total $\boldsymbol{E} = \boldsymbol{E}$ from equation 75 $+ \boldsymbol{E}$ from equation 76

A considerable amount of work may be saved by making use of equation 42, $\text{div } \boldsymbol{A} + (1/c)(\partial V/\partial t) = 0$. This is particularly true when the fields are sinusoidal functions of time, for then equation 42 becomes:

$$V = -\frac{c}{j\omega}\text{div } \boldsymbol{A} \qquad (79)$$

This result enables us to calculate V from $\boldsymbol{A}$ by differentiation which usually is much simpler than integration. The use of equation 42 can lead to no contradictions, because $\boldsymbol{i}$ and σ satisfy the equation of continuity.

Further saving of labor can be accomplished by making use of the fact that also

$$\text{div } \boldsymbol{A}^* + \frac{1}{c}\frac{\partial V^*}{\partial t} = 0 \qquad (80)$$

This equation is an exact analogue of equation 42. It can be proved by a process which amounts to a repetition of the proof of equation 42. When $\partial V^*/\partial t$ can be replaced by $j\omega V^*$, equation 80 saves us the integration for V^*.

The following is a summary of the simplified equations:

$$\boldsymbol{H} = \text{curl } \boldsymbol{A} - \frac{j\omega}{c}\boldsymbol{A}^* + \frac{c}{j\omega}\text{ grad (div } \boldsymbol{A}^*) \quad \text{[electromagnetic units]} \qquad (81)$$

$$\boldsymbol{E} = -\frac{j\omega}{c}\boldsymbol{A} + \frac{c}{j\omega}\text{ grad (div } \boldsymbol{A}) - \text{curl } \boldsymbol{A}^* \quad \text{[electrostatic units]} \qquad (82)$$

$$\boldsymbol{A} = \frac{1}{c}\iint\frac{[\boldsymbol{i}]}{r}dS, \qquad \boldsymbol{A}^* = c\iint\frac{[\boldsymbol{i}^*]}{r}dS \qquad (83)$$

The magnitude of $i = (c/2\pi)H_p$ and $i \perp H_p$

The magnitude of $i^* = (1/2\pi c)E_p$ and $i^* \perp E_p$

The last two relations may be written in vector notation:

$$\boldsymbol{i} = (\boldsymbol{n} \times \boldsymbol{H})\frac{c}{2\pi}, \qquad \boldsymbol{i}^* = -(\boldsymbol{n} \times \boldsymbol{E})\frac{1}{2\pi c}$$

where $\boldsymbol{n}$ is a unit vector normal to surface S and pointing into the guide.

The use of equations 42 and 80 accomplishes somewhat more than a mere saving of labor. These equations implicitly contain the conditions of continuity which $\boldsymbol{i}$ and σ and also $\boldsymbol{i}^*$ and σ^* must satisfy along surface S as well as on the edges of surface S. When we calculate V and V^* from equations 42 and 80, we can be sure that the continuity conditions have been taken properly into account. On the contrary, when we calculate V and V^* directly from 75 and 77, we should make sure that σ and σ^* are consistent with $\boldsymbol{i}$ and $\boldsymbol{i}^*$. This advantage is very real, because in practical applications it is often necessary to assume that S is not a closed surface but is only a portion of a closed surface. Under such conditions we must provide magnetic and electric line charges along the boundary of S, in order that the integrals for potentials be *extended over all charges and currents*, and so that the continuity conditions be satisfied on the boundary. The potentials of such line charges are not automatically included in V and V^* when these potentials are calculated directly from surface integrals. The potentials of the line charges have to be calculated separately by taking line integrals along the boundary of S, and these have to be added to V and V^*. All of this trouble is saved when V and V^* are calculated from equations 42 and 80.

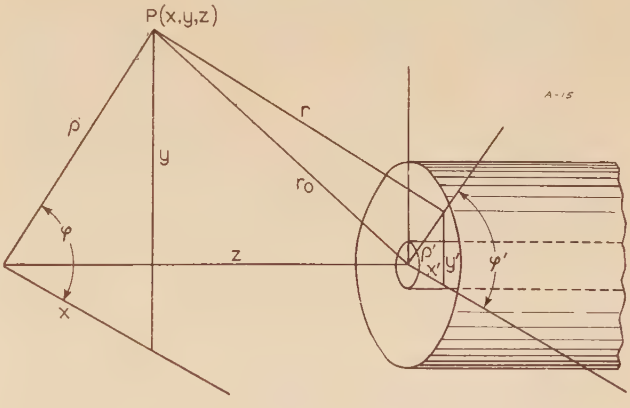


Figure 15. Open end of a concentric transmission line

In order to illustrate the application of this method let us calculate the radiation field of an open end of a concentric transmission line. For this purpose, let us take as surface S that portion of the xy plane in Figure 15 which is included between the outer and inner conductors of a concentric transmission line. We shall assume that along surface S the electric field is radial (just as it is inside the pipe at some distance from the open end) and that the lines of magnetic field are concentric circles around the axis of the conductors.

Let b be the radius of the outer conductor; let a be the radius of the inner conductor. Let x', y' be the co-ordinates of a point along surface S. Let x, y, z be the co-ordinates of a point P in space. Let

$$\rho' = \sqrt{x'^2 + y'^2} \qquad \frac{x'}{\rho'} = \cos\varphi' \qquad \frac{y'}{\rho'} = \sin\varphi'$$

$$\rho = \sqrt{x^2 + y^2} \qquad \frac{x}{\rho} = \cos\varphi \qquad \frac{y}{\rho} = \sin\varphi$$

$$r_0 = \sqrt{x^2 + y^2 + z^2} \qquad \frac{\rho}{r} = \cos\theta$$

In accordance with our assumptions, along S

$$E_\rho = \frac{Q}{\rho'}\epsilon^{j\omega t}$$

where Q is such that $\int_a^b E_\rho d\rho = v =$ the difference in voltage between the inner and outer conductors; hence $Q = v/(\log b/a)$. The other components of $\boldsymbol{E}$ are $E_\varphi = E_z = 0$.

The components of the magnetic field are: $H_z = 0$, $H_\rho = 0$, $H_\varphi = (R/\rho)\epsilon^{i\omega t}$. The value of R in this expression is related to the charging current I which flows from the inner conductors into space. This charging current consists of two parts, I_1 and I_2. Current I_2 is a pure displacement current which is in quadrature with E_ρ. Current I_1 is in phase with E_ρ. Current I_1 cannot be zero, for if it were the normal component of the Poynting vector $(c/4\pi)\boldsymbol{E}\times\boldsymbol{H}$ along S would be equal to zero, and no energy would pass through S into space; accordingly $H_\varphi \neq 0$, $R \neq 0$. Normally I_1 is small in comparison with I_2. The lines of force which emerge from the end of the inner conductor terminate on the end of the outer conductor. There are, therefore, electric surface charges on the end of the inner conductor and on the edge of the outer conductor. The fields of these surface charges will be automatically included in the calculation of the field produced by the equivalent distribution along surface S, even when this surface extends only over the aperture between the outer and inner conductors. These automatically included charges will be distributed along the two circles $\rho' = a$ and $\rho' = b$ which bound surface S. We could improve the accuracy slightly by extending surface S over the entire xy plane. This alternative has no great advantage, since it requires exact information in regard to the distribution of charges on the edges of the two conductors, and these distributions are not known in much greater detail than that taken into account when S extends only over the aperture. We shall therefore proceed on the assumption that S extends over the aperture.

Since $H_\rho = 0$, H_φ is the only component along S; therefore $H_p = H_\varphi$ and $i = (c/2\pi)H_\varphi$. Current $\boldsymbol{i}$ flows at right angles to H_φ, so that $i = i_\rho = (1/2\pi)H_\varphi$, $i_\varphi = 0$; $i_x = i_\rho \cos\varphi'$, $i_y = i_\rho \sin\varphi'$ and

$$A_x = \frac{1}{c}\int\int\frac{[i_x]}{r}dS = \frac{1}{c}\int\int\frac{[i_p]}{r}\cos\varphi'\,dS$$

$$A_y = \frac{1}{c}\int\int\frac{[i_y]}{r}dS = \frac{1}{c}\int\int\frac{[i_p]}{r}\sin\varphi'\,dS$$

$$A_z = 0$$

Cylindrical co-ordinates are more convenient:

$$A_\varphi = 0$$

from symmetry and

$$A = A_\rho = A_x\cos\varphi + A_y\sin\varphi = \frac{1}{c}\int\int\frac{[i_p]}{r}\cos(\varphi' - \varphi)dS$$

Since

$$[i_p] = \left[\frac{c}{2\pi}H\varphi\right] = \frac{Rc}{2\pi\rho}\epsilon^{j\omega t - jkr}$$

we have

$$A = \frac{R\epsilon^{j\omega t}}{2\pi}\int_a^b\int_0^{2\pi}\frac{\epsilon^{-jkr}}{r.\rho}\cos(\varphi' - \varphi)\rho d\rho d\varphi$$

where

$$k = \frac{\omega}{c}, \qquad r = \sqrt{(x' - x)^2 + (y' - y)^2 + z^2}$$

The value of A^* is found by a similar process. This time $i^* = (1/2\pi c)E_\rho$ and $i^* \perp E_\rho$ so that $i_\rho = 0$

$$i_\varphi^* = i^* = \frac{1}{2\pi c}E_\rho = \frac{Q}{2\pi c}\frac{1}{\rho}\epsilon^{j\omega t}; \quad i_x^* = -i_\varphi^*\sin\varphi', \; i^* = +i_\varphi^*\cos\varphi'$$

$A_\rho^* = 0$ by symmetry

$$A_\varphi^* = -A_x^*\sin\varphi + A_y^*\cos\varphi$$

and

$$A^* = A_\varphi^* = c\int\int\frac{[i_\varphi^*]}{r}\cos(\varphi' - \varphi)dS$$

$$A_\varphi^* = \frac{Q\epsilon^{j\omega t}}{2\pi}\int^b\int_0^{2\pi}\frac{\epsilon^{-jkr}}{r\rho}\cos(\varphi' - \varphi)\rho' d\rho' d\varphi'$$

The integrals for A_ρ and A_φ^* become very simple if we assume that b is small in comparison with both λ and r, and that λ is small in comparison with r. In this case if $r_0 = \sqrt{x^2 + y^2 + z^2}$,

$$r = \sqrt{(x - x')^2 + (y - y')^2 + z^2}$$

$$\approx r_0 - \frac{xx'}{r_0} - \frac{yy'}{r_0}$$

$$\approx r_0 - \frac{\rho}{r_0}\frac{x}{\rho}x' - \frac{\rho}{r_0}\frac{y}{\rho}y'$$

$$\approx r_0 - \rho'\sin\theta(\cos\varphi\cos\varphi' + \sin\varphi\sin\varphi')$$

$$\approx r_0 - \rho\;\sin\theta\cdot\cos(\varphi' - \varphi)$$

and

$$\frac{1}{r} = \frac{1}{r_0}\left[1 + \frac{\rho'}{r_0}\sin\theta\cos(\varphi' - \varphi)\right]$$

$$\epsilon^{-jkr} = \epsilon^{-jkr_0}.\epsilon^{jk\rho'\sin\theta\cos(\varphi' - \varphi)}$$

$$\approx \epsilon^{-jkr_0}[1 + jk\rho'\sin\theta\cos(\varphi' - \varphi)]$$

$$\frac{1}{r}\epsilon^{-jkr} \approx \frac{\epsilon^{-jkr_0}}{r_0}[1 + jk\rho'\sin\theta\cos(\varphi' - \varphi)]$$

If we introduce this approximate value of $(1/r)\epsilon^{-jkr}$ into the integral for A we get

$$A=\frac{R\epsilon^{j\omega t-jkr_0}}{2\pi r_0}\int_a^b\int_0^{2\pi}[1+jk\rho'\sin\theta\cos(\varphi'-\varphi)]\cos(\varphi'-\varphi)\times d\rho' d\varphi'$$

$$=\frac{jkR\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin\theta$$

An almost identical calculation gives us

$$A^*=A_\varphi^*=\frac{jkQ\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin\theta$$

In order to calculate div $\boldsymbol{A}$ and div $\boldsymbol{A}^*$, curl $\boldsymbol{A}$ and curl $\boldsymbol{A}^*$, it is best to resolve $\boldsymbol{A}$ and $\boldsymbol{A}^*$ into their components in spherical co-ordinates A_{r_0}, A_φ, A_θ. Since $A=A_\rho$ and $A^*=A_\varphi^*$ we have

$$\begin{aligned} A_{r_0}&=A_\rho\sin\theta \qquad & A_{r_0}^*&=0\\ A_\theta&=A_\rho\cos\theta & A_\theta^*&=0\\ A_\varphi&=0 & A_\varphi^*&=A \end{aligned}$$

and

$$\text{div }\boldsymbol{A}=\frac{1}{r_0^2}\frac{\partial(r_0^2A_{r_0})}{\partial r_0}+\frac{1}{r_0\sin\theta}\frac{\partial}{\partial\theta}(A_\theta\sin\theta)+\frac{1}{r_0\sin\theta}\frac{\partial A_\varphi}{\partial\varphi}$$

$$=-\frac{(jk)^2R\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin^2\theta+\text{ terms of order }\frac{1}{r_0^2}$$

$$\text{div }\boldsymbol{A}^*=0$$

$$(\text{curl }\boldsymbol{A})_{r_0}=\frac{1}{r_0\sin\theta}\left[\frac{\partial}{\partial\theta}(\sin\theta A_\varphi)-\frac{\partial A\theta}{\partial\varphi}\right]=0$$

$$(\text{curl }\boldsymbol{A})_\theta=\frac{1}{r_0}\left[\frac{1}{\sin\theta}\frac{\partial Ar}{\partial\varphi}-\frac{\partial}{\partial r_0}(r_0A_\varphi)\right]=0$$

$$(\text{curl }\boldsymbol{A})_\varphi=\frac{1}{r_0}\left[\frac{\partial}{\partial r_0}(r_0A_\theta)-\frac{\partial Ar}{\partial\theta}\right]$$

$$=-\frac{(jk)\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin\theta\cos\theta+\text{terms of order }\frac{1}{r_0^2}$$

$$(\text{curl }\boldsymbol{A}^*)_{r_0}=0$$

$$(\text{curl }\boldsymbol{A}^*)_\theta=\frac{(jk)^2\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin\theta$$

$$(\text{curl }\boldsymbol{A}^*)_\varphi=0$$

$$\text{grad}_{r_0}(\text{div }\boldsymbol{A})=\frac{(jk)^3R\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)\sin^2\theta+\frac{1}{r_0^2}\text{ terms}$$

$$\text{grad}_\theta(\text{div }\boldsymbol{A})\doteq\frac{1}{r_0^2}\text{ terms only}$$

$$\text{grad}_\varphi(\text{div }\boldsymbol{A})=0$$

By substituting these values into equations 81 and 82 we obtain

$$E_\varphi=0$$
$$E_r=0$$

$$E_\theta=-\frac{(jk)^2\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)(R\sin\theta\cos\theta+Q\sin\theta)$$

$$H_\varphi=-\frac{(jk)^2\epsilon^{j\omega t-jkr_0}}{4r_0}(b^2-a^2)(R\sin\theta\cos\theta+Q\sin\theta)$$

$$H_r=0$$
$$H_\theta=0$$

It is well at this point to make the following observations: if the current which flows into the charge at the end of the inner conductor is $I=I_1+jI_2$, the magnetic field $\boldsymbol{h}$ of this current near the end of the conductor is not $2I/c\rho$ but $I/c\rho$. This is particularly easy to see when the inner conductor is thin. In fact, since ρ is small in comparison with λ we may, in this case, calculate the magnetic field directly from the Biot-Savart law

$$h=\frac{1}{c}\int_0^\infty\frac{I\sin\theta}{z^2+\rho^2}dz=\frac{1}{c}\int_0^\infty\frac{I\rho dz}{[z^2+\rho^2]^{3/2}}=\frac{I}{c\rho}$$

When this same integration is extended from $-\infty$ to $+\infty$, it results in the usual $2I/c\rho$. The result is easy to understand: one half of the conductor produces one half of the field.

By equating $h=I/c\rho$ with $H_\varphi=R/\rho$, we find that $I=cR$. It is interesting to compare current I which produces H_φ with the total equivalent current $2\pi ai$ which flows into the inner boundary of surface S. Since $i=(c/2\pi)H_\varphi$, and H_φ at $\rho=a$ is R/a, we see that $2\pi ai=Rc=I$. From this simple result one can draw the following conclusion: as the actual current I which flows into the actual charge at end of the inner conductor is equal to the "equivalent" surface current which flows into the boundary charge along the inner boundary of S, these two charges must also be equal. Since the field of this boundary charge is automatically included in the field of current and charge distribution along S, we do not need to add any additional terms to allow for the end charge on the inner conductor. A similar reasoning shows that no allowance need be made for the charge at the end of the outer conductor, because this charge is equal to the outer boundary charge on S, and is therefore already taken into account.

This conclusion can be verified by computing the scalar potential of the two ringlike charges by direct integration. If δ is the line density along the inner ring charge, $q=-2\pi a\delta$, then the scalar potential $V=(\epsilon^{j\omega t}\int_0^{2\pi}\delta\epsilon^{-jkr}/r)a\,d\varphi$. Similarly, the scalar potential of the ring charge on the outer conductor is $V'=(\epsilon^{j\omega t}\int_0^{2\pi}\delta'\epsilon^{-jkr}\times r)bd\varphi$ where δ' is such that $q=2\pi b\delta'$. The potential of both rings is $V+V'$. These integrations are easily carried out if ϵ^{-jkr}/r is expanded as before, except that this time it is necessary to keep three terms, because the first two cancel out. The result is

$$V+V'=q\frac{(jk)^2}{4r_0}\epsilon^{j\omega t-jkr_0}(b^2-a^2)\sin^2\theta$$

Since

$$\frac{\partial q}{\partial t}=2\pi ai=2\pi a\frac{c}{2\pi}\frac{Q}{a}\epsilon^{j\omega t}\qquad q=\frac{c}{j\omega}Q=\frac{1}{jk}Q$$

If we substitute this value of q into $V+V'$, we see that $V+V'$ is identical with $(1/jk)$div $\boldsymbol{A}$, which is exactly what is to be expected from equation 42.

The procedure for calculating the radiation resistance is substantially the same as that which was used to calculate the radiation resistance of the dipole, except that this time we have yet to find the inphase component I_1 of current I. The total radiated power is

$$P=\frac{c}{8\pi}\int_0^{2\pi} d\varphi \int_0^{\pi} (\boldsymbol{E}\times\boldsymbol{H})\cdot\boldsymbol{r}_0\, r_0 \sin\theta d\theta$$

Since

$$R=\frac{I_1+jI_2}{c}, \qquad P=\frac{c}{4}\frac{k^4}{16}(b^2-a^2)^2\left\{\frac{1}{c^2}(I_1{}^2+I_2{}^2)\frac{4}{15}+Q^2\frac{4}{3}\right\}^{\dagger}$$

This same power passes through surface S and can be calculated from the Poynting vector along S. Along this surface $H=H_\varphi=Q/\rho$, $E=E_\rho=R/\rho$, $\boldsymbol{H}\perp\boldsymbol{E}$.

The power passing through surface S therefore equals

$$P=\frac{c}{8\pi}\int^{2\pi} d\varphi \int_a^b H_\varphi E_\rho\, \rho d\rho=\frac{I_1}{4}Q\log\frac{b}{a}=\frac{I_1 v}{4}$$

By equating the two expressions for the same power, we can calculate I_1 when voltage v between conductors and the quadrature charging current I_2 are known. Once I_1 has been found, we can evaluate the radiation resistance which may be defined in the following manner:

$$\left(\frac{I_1}{\sqrt{2}}\right)^2 R=P=\frac{I_1 v}{4}$$

CONCLUSION

We have described two methods which are used in making calculations of radiation fields. The first method is convenient for calculating the field of a radiator with a known current distribution. This method has been very helpful in the development of antennas. The second method is useful when the field near the radiator is known. This method is relatively new and is still somewhat in a state of flux. This method is replacing the Kirchhoff-Huygens procedure which has been used in early calculations of radiation from wave guides, electromagnetic horns, and so forth. Method 2 seems to be superior to the Kirchhoff-Huygens procedure, because in method 2 one is dealing with currents and charges which are familiar, whereas in the Kirchhoff-Huygens procedure one has to use a function, the physical meaning of which is not clear. A considerable number of erroneous results has been obtained by applying the Kirchhoff-Huygens procedure to problems involving apertures because of the difficulty of finding the proper function which must be added to take care of conditions along the boundary of an aperture.

In describing methods 1 and 2, it has been our aim to derive all expressions directly from physical concepts. Sometimes this was done at the expense of mathematical rigor.

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† When either $\boldsymbol{H}$ or $\boldsymbol{E}$ or both are complex, one should keep in mind that $a+jb$ stands for $a\cos\omega t+b\sin\omega t$. This fact is used in calculating the time average over the cycle.

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Less Critical Materials in Critical Instruments

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ELECTRICAL instruments and various related measuring devices constitute the "critical components" of many different kinds of war equipment, such as ships, tanks, and airplanes. Although the material content of each unit of these "critical components" is relatively small compared with many other wartime products, the large quantities in which the devices are being manufactured to meet present production schedules require large aggregate amounts of material, most of which are of the "scarce" classifications. The necessity for conservation in the use of materials in instrument production is therefore a matter of great importance and one which has been and is being given careful attention at present.

Logically, the program for this material-conservation effort falls into six subdivisions as follows:

1. Use of alternate materials.
2. Adaptation of designs to use less material.
3. Development of new materials.
4. Utilization of scrap and secondary supplies.
5. Use of surplus stocks.
6. Conservation by improved workmanship.

These six ways of making the most efficient use of materials in instrument manufacture have been utilized in the West Lynn Works, of the General Electric Com-

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pany, and substantial savings of critical materials have been achieved thereby.

The experience of a manufacturer of combat instruments and other electrical measuring devices, many of which are "critical components" of fighting equipment, shows that worth-while contributions to the war effort can be achieved by a well-rounded material-conservation program.

In planning the conservation program certain limitations and complications had to be considered. Not only are instruments and related devices now being produced in unprecedented quantites—as vital components of aircraft, ships, electronic products, and many other modern implements of war—but they are needed also, though in smaller quantities, in essential war industries to improve efficiency, expand productivity, save materials, and protect manufacturing facilities. It is, therefore, neither wise nor advantageous to substitute less scarce alternates at the expense of quality and performance—a temporary expedient which can be resorted to in the case of a number of civilian products.

On the contrary, rigorous conditions of modern warfare with wide extremes of temperature, severe vibration, and high shock require performance in many ways superior to that demanded of most peacetime applications. These conditions, translated into the exacting Army and Navy specifications to which combat instruments must conform, have the effect of limiting the number of kinds of materials that can be used for specific purposes. Although the armed forces, with the co-operation of the manufacturers involved, have made substantial progress in revising specifications to allow a wider choice of materials and to encourage conservation, it is obvious that any action jeopardizing the service performance and the dependability of a device must be avoided at all cost.

The material-conservation program for electrical measuring devices is complicated, in addition, by the fact that these devices require many different kinds of critical materials. For example, the long-scale, concentric-magnet-type voltmeter for switchboards, shown in Figure 1, uses the materials listed in the caption. The quantity of each material is of course small, as the complete instrument weighs only $3^3/_4$ pounds. Other measuring devices have used, in addition to those listed, such scarce constituents as magnesium, tantalum, molybdenum, platinum, mica, tung oil, toluol, and many more. It is difficult to find an item on the War Production Board's list of most critical materials which has not been used at least in small amounts in a well-rounded line of electrical measuring equipment.

In spite of the limitations and complications involved in conserving critical materials for electrical measuring devices, large savings already have been made, and more will result as projects still in development reach the stage of practicable manufacture.

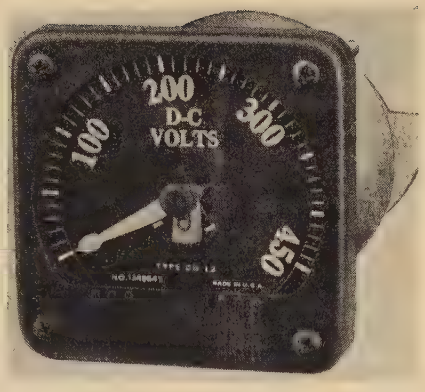
USE OF ALTERNATE MATERIALS

The use of less scarce alternates is perhaps the most straightforward conservation measure, although such changes often involve rather extensive design and process modifications in order to assure continued good performance and high quality. Watt-hour meters, for example, were subjected to a thorough conservation study even before Pearl Harbor because of their relatively large use of aluminum, the first material to become critical. Figure 2 shows a typical domestic meter and indicates the alternate materials that have been used.[1] For each part originally made or finished with aluminum, copper or its alloys, tin, nickel, or other critical materials, alternates were tested and evaluated carefully with respect to both suitability and future availability. As a result, the alternates were introduced with no appreciable change in watt-hour-meter characteristics or useful life and without interruptions in manufacture. Net annual savings in watt-hour meters of the types produced in the West Lynn Works amounted to approximately 1,000,000 pounds of aluminum, 130,000 pounds of copper, 45,000 pounds of nickel, 3,400 pounds of cadmium, and 2,000 pounds of tin. In addition, critical constituents of varnishes and plastics were changed to conserve sizable quantities of toluol and formaldehyde.

These savings are based on the rate at which these watt-hour meters were being produced when the alternate materials were introduced during the last half of 1941 and early in 1942. Subsequently, the tremendous requirements of the war program caused severe shortages of the remaining materials, particularly of copper, which could not be removed entirely from the meter and which was the only practical substitute for aluminum for certain parts. To make these materials available for fighting equipment, a drastic curtailment of watt-hour-meter production was effected by the War Production Board, despite the great value of these devices as a means of conserving electric energy. Nevertheless, the experience of introducing alternates, to save critical materials in these devices without jeopardizing performance, has been extremely valuable in planning conservation programs for more critically needed measuring equipment.

Obviously, all the changes made to conserve material in wartime electrical instruments and associated equipment cannot be included in this review, but a few examples are worth noting. The aluminum previously used for many housings, cases, and supporting frames has been replaced wherever practical by cast iron, fabricated steel, die-cast zinc, sheet zinc, cast secondary bronze, or other materials, as determined by the requirements of the application. In each instance the least critical material which satisfied the requirements was chosen, after samples were tested for stability, expansion with temperature, magnetic effects, and other characteristics essential to maintaining the high-quality per-

Figure 1. Long-scale d-c voltmeter for switchboards



Materials used in the switchboard voltmeter:

Aluminum
Copper
Brass
Phosphor bronze
Cobalt
Tin
Zinc
Nickel
Lead
Carbon steel
Alloy steel
Iron
Sapphire
Fiber
Cork
Silk
Rayon
Shellac
Ivory
Ceramic material
Phenolic plastic
Methyl methacrylate plastic
Synthetic insulations
Photographic paper
Miscellaneous organic finishes

formance of the device. Since the alternate materials are usually less resistant to corrosion than the original aluminum, adequate protective finishes were selected to render the completed parts as impervious to corrosive action as aluminum. The new parts do, of course, weigh somewhat more than the old ones, but because of the comparatively small size of most instrument parts this change should not cause difficulty. Of far greater importance is the fact that this year these instruments will not use over 50,000 pounds of aluminum that would otherwise have been required at this plant.

Similarly, either zinc, decalcomanias, or fiber have replaced aluminum and brass for rating plates; brass supporting studs and plates have been changed to steel; and carbon steel has been substituted for stainless where corrosion and magnetic conditions permitted. Nickel, tin, and cadmium platings, and aluminum lacquer continue to be used only where really necessary for functional reasons and in many instances have been replaced by silver, zinc, or more available sprayed finishes. Critical nonmetals such as rubber have been changed first to reclaimed grades and then in certain cases to the more available synthetic types. The lower grades of domestic mica have been used in place of the scarce imported varieties. The use of shellac and silk has been drastically curtailed by the utilization of synthetic varnishes and textiles, and tung oil and toluol have been eliminated.

In an effort to save the relatively small amounts of tin used in solder, all soldering operations were investigated carefully, with several interesting results. It was found that in a number of cases the substitution of welding or brazing not only saved the tin but also provided stronger more permanent connections. In other applications where the parts to be joined are relatively large, it has been possible to reduce the tin content of the solder from 40 or 50 per cent to 20 per cent without impairing the quality of the joints. However, for ultrafine wire, which is used in instruments in sizes as small as 0.001 inch in diameter, and for other delicate parts such as control springs, lowering of tin content requires a sufficient increase in soldering iron temperature to damage these parts. Moreover, the prime importance of sound soldered joints, the difficulties inherent in soldering these small parts, and the necessity of training hundreds of new employees for expanded production emphasize the wisdom of using the most satisfactory solder, irrespective of tin content, for such applications.

ADAPTATION OF DESIGNS TO USE LESS MATERIAL

Conservation by the use of alternates, while of great value in channeling the most critical materials to the most vital war needs, is definitely limited. The resulting use of the alternate materials can easily increase sufficiently to make them almost as scarce as the originals which they replace. Moreover, for many uses the possible alternates are relatively few. In electrical measuring devices, the copper used for conductors is an excellent example of this situation. For nearly every application the only alternates that can be considered are aluminum and silver. Aluminum is ruled out immediately, because it is even scarcer than copper, and silver can be obtained in such relatively small quantities that any large-scale substitution of it for copper would rapidly exhaust the entire supply of silver. Nevertheless, copper stands high on the list of materials which are available in insufficient amounts for war demands and, therefore must be conserved. This can be accomplished only by designing to use less copper.

An excellent example of what can be accomplished to conserve materials by this approach is the redesign of a line of indoor dry-type instrument transformers to use

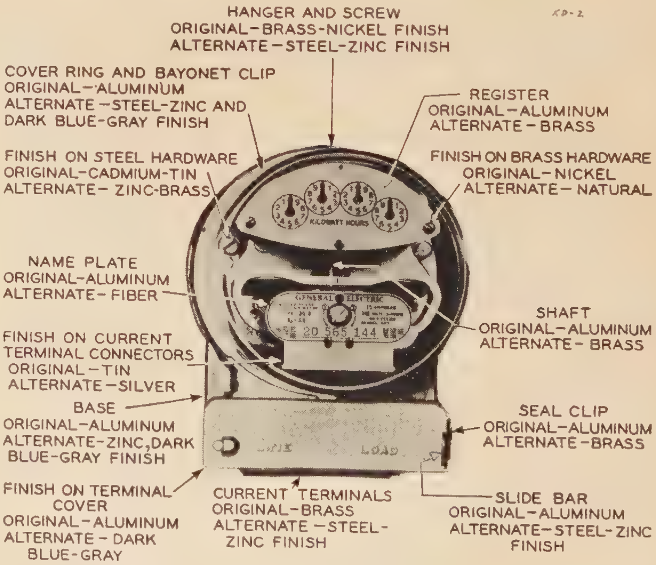


Figure 2. Original and alternate materials used in single-phase watt-hour meters

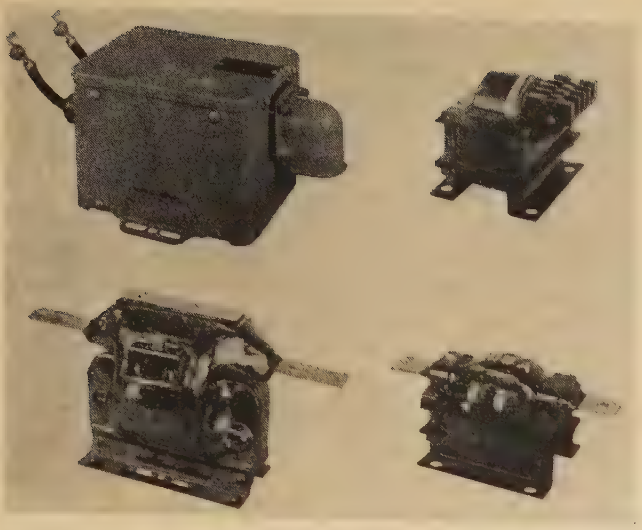


Figure 3. New material-saving potential and current transformers (right) compared with the types they replaced (left)

less copper and steel.[2] A detailed analysis of applications and specifications showed that a substantial portion of the orders for these devices was being filled by supplying transformers with either higher accuracies or greater capacities than required. It was concluded, therefore, that, if instrument transformers were designed to meet but not exceed the requirements of special applications, and if these designs could be put in production without appreciable retooling, large amounts of both copper and steel would be saved. Such a program is well under way, and designs for six types have been completed. Although these were introduced in the latter part of 1942, they have already reduced copper usage by over 100,000 pounds and steel by about 140,000 pounds. It is expected that in 1943 a total of 130,000 pounds of copper and 173,000 pounds of steel will be saved by applying the new designs to special applications.

The potential and current transformers shown on the right-hand side of Figure 3 are typical of these six designs which do the job with less material. At the left, for comparison, are the standard types which were supplied previously for marine switchboards, when such applications were few, materials were plentiful, and the introduction of nonstandard types was not justified. In addition to using far less copper and steel, the new transformers are better able to withstand the high shocks and rough service of modern sea warfare because of their compact rugged construction, and they meet Navy specifications in all respects. Each of the six designs was laid out to use existing equipment, so that only a few pounds of steel were required for simple drill jigs and similar tools in order to start large-scale production.

Instruments themselves have also been designed to use less material. A recently developed dual tachometer for aircraft conserves both space and material by providing in one instrument the indication that previously required two instruments of about the same size. Approximately 16 square inches of the aircraft instrument panel are thus released for other essential needs. The material savings resulting can be illustrated best by the fact that the authors' plant, which is just one of the several manufacturers of this design, expects to use this year 33,000 pounds less aluminum than would be required to provide equivalent instrumentation with the older single-element design.

A novel construction[3] and the use of new materials enable the pointer of the concentric-magnet switchboard instrument, of the type shown in Figure 1, to move through an angle of 240 degrees. A 6.8-inch scale length is thus obtained in an instrument $4^1/_4$ inches square to provide greater ease of readability in a relatively small area. A complete line of these instruments was designed to supersede the more conventional $5^1/_2$-inch rectangular construction having 105-degree scale arcs. In Figure 4, a comparison of these two types shows that the newer design requires about 33 per cent less space, and at the same time its scale length is 35 per cent longer. In addition to the material savings in the switchboard structure resulting from the compactness of these designs, the amount of critical materials to be used in producing the

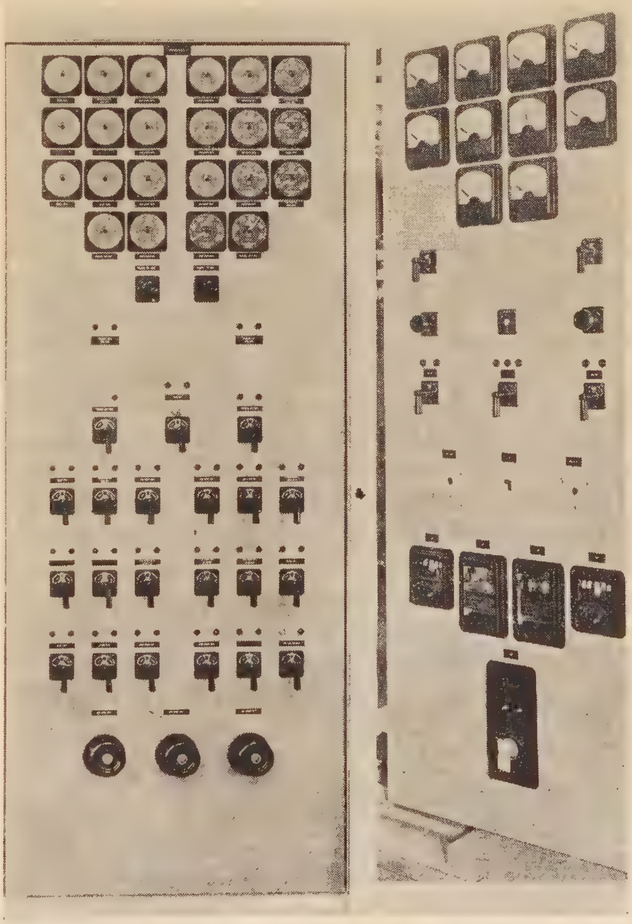


Figure 4. Switchboard panel equipped with concentric-magnet instruments (left) compared with a panel using the older types of instruments (right)

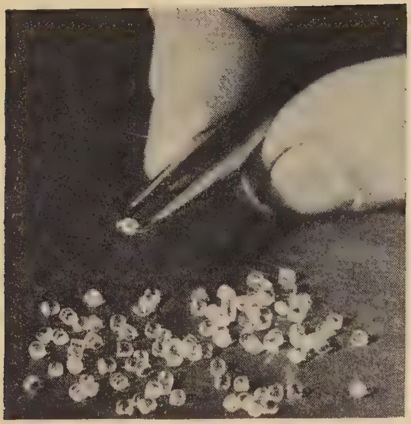


Figure 5. Glass Vee jewels for miniature instruments

1943 output will be approximately 30,000 pounds less than that necessary for a corresponding number of the $5^1/_2$-inch rectangular types. Moreover these long-scale instruments recently have been modified to withstand unusually severe war conditions, thus eliminating the need, this year, for 137,000 pounds of the soft pure rubber in which previous designs were mounted.

The preceding examples serve to point out that, wherever new electrical measuring devices are being developed, engineers should emphasize conservation of material and space as primary requirements and can make substantial savings by designing to use less material and space.

DEVELOPMENT OF NEW MATERIALS

Because electrical measuring devices require relatively small quantities of the critical materials compared with other war equipment, the material shortage alone has not threatened to place serious restrictions on the production of vitally needed combat instruments, with one important exception. This exception was the sapphire jewel used almost universally for bearings in prewar electrical instruments. The manufacture of sapphire bearings is a highly specialized art, with the bulk of the equipment and skill being located in Europe, principally in Switzerland. As a result of the curtailment of the supply from abroad, together with the vastly expanded war demand for instruments, a threat arose that this material would run out or at least that instrument production would be restricted to numbers far below indicated needs. This situation necessitated an approach to material conservation quite different from those previously described. Obviously a new material was needed.

The requirements of a material to replace sapphire instrument jewels are unusually exacting for the reason that high instrument accuracy depends to a large extent on the dimensional precision and low friction of the bearings. Moreover, the material must be sufficiently hard to permit minute contact areas, which minimize friction torque, and at the same time withstand severe wartime service without damage that would impair performance.

The prewar popularity of bearing made of sapphire, which is in the group of materials next in hardness to diamond, depended on the ingenious, though delicate and tedious, methods developed abroad for grinding and polishing it. Establishing similar processes in this country was of course possible and has in fact proceeded with considerable success. It has been obvious, however, that the high skills which had to be developed precluded obtaining sufficient bearings by such a program in time to meet expanded war demands.

The particular type of sapphire bearing for which a severe shortage was first felt was the small Vee jewel used in small panel electrical indicating instruments. Two of these Vee jewels are required to support the instrument moving system which is carried on two extremely sharp pivots to form the other parts of the two bearings. The extremely small radii of the spherical ends of the pivots, designed to keep the effect of friction at a minimum, cause bearing pressures of the order of several hundred thousand pounds per square inch when the moving system is in a vertical position.[4] The need for hard bearing materials to resist deformation when the instrument is subjected to impacts is obvious.

In developing new bearings which would replace adequately the sapphire Vees and could be made available rapidly in large quantities, the experience of some 25 years ago with glass jewels has been a substantial help.[5] Such jewels were used at that time because of the unsatisfactory dimensional characteristics of the sapphire Vees then obtainable. Improvements in the sapphire cutting technique subsequently led to abandoning the glass jewels, which at the time were thought to be too soft to be entirely satisfactory in their resistance to impact.

As a shortage of sapphire Vees became imminent, intensive investigation and development were started at the plant with which the authors are associated to determine the best material available, to evaluate its performance compared with that of sapphire, and to design and build satisfactory mass-production equipment capable of meeting the ever-increasing demands. The progress made by the glass industry during the past few years in making new types of harder glass was used to advantage. As the result of many tests, a material was chosen which could be formed in semiautomatic machines to provide very smooth highly polished bearing surfaces of accurate dimensions.

This hard glass has been shown to have a coefficient of friction within the range of the sapphire previously used, and measurements of jewel roll indicate that it is at least equivalent if not superior to sapphire in this respect. Although the hardness of the new glass jewel is not as high as that of sapphire, it is entirely adequate for small panel instruments, since the greater hardness of sapphire is of no appreciable advantage in instruments having moving systems weighing less than 0.75 gram. As a result, the over-all performance of such instruments equipped with glass jewels is equivalent in every way to that of the same types built with sapphire.

Once a material was found to replace sapphire Vees with no sacrifice in small-panel-instrument performance, equipment was developed rapidly, and production of the glass jewels shown in Figure 5 was stepped up to a point which eliminated the possibility of restrictions on instrument output caused by a shortage of Vee jewels. At present, virtually all small panel instruments in the country are manufactured with glass bearings instead of sapphire, and over 80 per cent of the total demand for instrument Vee jewels is being supplied by the use of glass.

The development of glass Vees in quantity production was followed closely by similar activity to provide hard glass ringstones for use in place of sapphire ringstones, a shortage of which threatened to restrict the manufacture of certain types of combat instruments. Ringstones are required in these instruments for various journal bearings and must be held to extremely close tolerances. As in the case of the Vees, the glass ringstones can replace their sapphire predecessors without perceptible sacrifice of instrument performance and lend themselves to quantity production methods. The development of these two types of hard glass jewels, together with domestic processing of sapphire jewels as developed, by various specialty manufacturers, for larger instruments in which glass would affect performance adversely, has enabled the wartime instrument industry to be practically independent of foreign sources and to expand with unprecedented speed.

UTILIZATION OF SCRAP AND SECONDARY SUPPLIES

Using collected scrap in the making of Alnico permanent magnets for instruments is another method of conserving materials. This high-energy alloy material which has been developed rapidly during the past few years has contributed substantially to the new compact instruments with improved performance shown in Figures 1 and 4 and to many other recent designs.[6] Figure 6 illustrates a number of types of Alnico permanent magnets which currently are being cast and finished for electrical measuring devices.

The Alnico alloy, as its name implies, is cast from a melt made of aluminum, nickel, and cobalt, as well as other materials, depending on the type. One of the most commonly used types, Alnico II, contains approximately 10 per cent aluminum, 17 per cent nickel, $12^1/_2$ per cent cobalt, 6 per cent copper, and the remainder iron. Because the magnetic strength and other qualities of Alnico magnets are very sensitive to variations in the proportions of these constituents, they must be controlled carefully and, prior to the war, were obtained by adding high-purity virgin metal to remelted Alnico sprues.[7] With the outbreak of hostilities, the need for developing additional secondary sources of material became apparent, and work to this end was undertaken at the plant with which the authors are connected.

Cobalt was the first to become scarce, because imports from refineries in Belgium were cut off by the German occupation of that country. A cobalt-bearing alloy, known as "crude cobalt" and containing in addition to cobalt approximately 43 per cent iron and 16 per cent copper, plus various impurities, was, however, made available by shipment from the Belgian Congo. To make use of this alloy, a method of removing the impurities and a new technique for combining the constituents of Alnico to utilize the iron and copper as well as the cobalt were developed. After the impurities were removed, an analysis was made of this master alloy, and it was balanced to the desired composition. The introduction of this process not only avoided any production delays caused by the scarcity of cobalt, but it actually resulted in an increase of magnet damping strength of almost ten per cent, as shown by the curve in Figure 7. The improvement must be attributed to the higher over-all purity of the Alnico.

Moreover this new method was well adapted to the use of secondary sources of nickel and aluminum, as the supply of these metals became critical. Turnings and punch-press skeletons of high nickel alloys were utilized first without serious problems arising. Because the available quantities of such scrap were insufficient, various worn-out and discarded nickel-bearing products were accumulated. These otherwise useless parts were refined in order to obtain from them additional nickel which could be utilized satisfactorily. For the aluminum requirements, arrangements were made to replace the virgin metal originally used with secondary aluminum which is considerably more plentiful. In addition, a process was developed for reclaiming the fine grinding dust occurring at the cutting off and other operations performed in finishing Alnico magnets. These grindings, together with miscellaneous Alnico foundry scrap which ordinarily was discarded, are now used to provide a substantial portion of the materials required. As a result practically all of the nickel, aluminum, and copper, and a large portion of the cobalt and iron needed for Alnico permanent magnets manufactured at the authors' plant are secured without drawing on the nation's virgin metal.

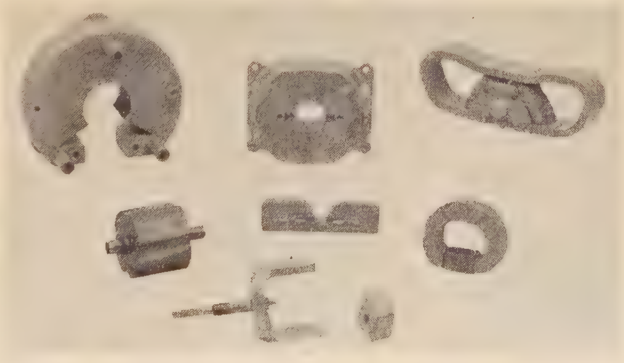


Figure 6. Typical Alnico II permanent magnets used in electrical measuring devices

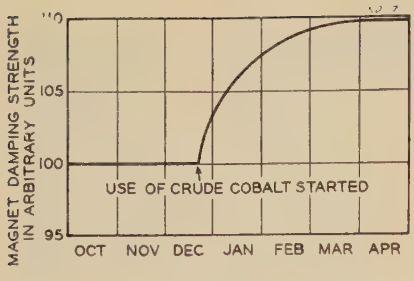


Figure 7. Change in Alnico-permanent-magnet damping strength after use of crude cobalt was begun

USE OF SURPLUS STOCKS

In these days of critical-material shortages, it is at times hard to understand the existence of certain surplus items. The necessity for converting many manufacturing plants to war production with great rapidity, however, precluded careful planning and has resulted in excess stocks of certain kinds of fabricated materials, semifinished parts, and even completed products. Various units of the War Production Board have been successful in channeling these excesses to war industries, and manufacturers of electrical measuring devices have co-operated in this work. The latter have also been able to arrange the utilization of certain excess parts and devices of value only in the measurement field. For example, glass Vee jewels were developed and introduced in small panel instruments so rapidly that a considerable number of sapphire Vees, made originally for these instruments, were still available after the glass jewels were introduced. This surplus of sapphire jewels, therefore, was used for larger instruments, whose heavier moving systems required the greater hardness of sapphire—this being made possible by changing the design of the jewel setting as shown schematically in Figure 8. As a result, a shortage of sapphire Vees for these larger types has been avoided, at least until the domestic production of the larger sapphire jewels is adequate to meet the requirements.

Surplus stocks of the single-phase watt-hour meter, shown in Figure 2, were also adapted to meet war requirements. Restrictions as to types of installations for domestic electric-power consumers caused a sudden shift in demand from the three-wire type meters to the two-wire style, and existing stocks accumulated for anticipated requirements were out of balance with actual needs. Sets of conversion parts were, therefore, designed with which the three-wire meters could be converted readily for use on two-wire applications. One of these sets contains less than an ounce of copper, brass, and steel, and a few inches of insulation. With it, a meter of the three-wire type, which required 9.4 pounds of critical materials to build, can be changed, by using only a screw driver and pliers, so as to perform an essential service with complete satisfaction. These conversion sets are available to public utilities and thus surpluses of one type are utilized to relieve shortages of another.

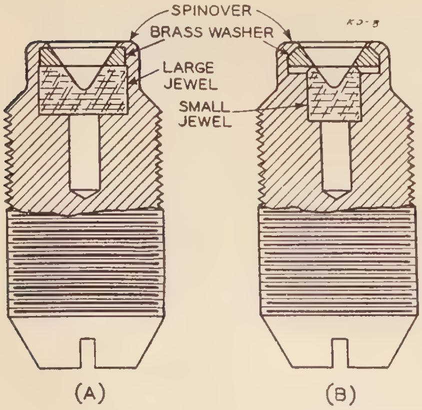


Figure 8. The older method for setting sapphire jewels (a) was changed as in (b) to utilize smaller sapphire jewels for heavier moving systems

CONSERVATION BY IMPROVED WORKMANSHIP

The five methods of critical-material conservation, previously described, have been undertaken chiefly by design engineers and material and process experts, with some assistance from purchasing and sales departments. To the sixth major method, however, everyone working in a manufacturing plant can make worth-while contributions. Large savings of critical materials would be made if every part produced met specifications and none were rejected and scrapped. Although such perfection is more than can be expected of any group, especially those engaged in manufacturing delicate high-precision measuring devices, much can be accomplished by emphasizing this possibility of conservation to all concerned. For this purpose, educational publicity methods have been used effectively, both nationally and by individual industrial concerns, to explain and encourage improved workmanship as a means of saving critical materials.

A well-co-ordinated program of this nature at the West Lynn Works has been fully justified. Since its inception in the latter part of 1941, improved workmanship has resulted in substantial reductions in the amount of scrap material per employee. In 1942, despite the rapid increase of new workers and the loss of many skilled men to the armed forces, these reductions resulted in savings equivalent to over 2,000 tons of critical materials and many thousands of productive man-hours. This experience shows that the decrease of spoilage factors in the manufacture of war equipment should not be overlooked as an effective material-conservation measure.

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Nikola Tesla's Achievements in the Electrical Art

"In the interval since Tesla did his really great creative work his name has been associated with so many projects of questionable scientific quality that I imagine they may have raised doubts in the minds of many as to his real achievements" (Doctor Frank B. Jewett in a letter dated January 1943). The Edison Medal (1916) was awarded by the AIEE to Tesla "for his early original work in polyphase and high frequency alternating currents."[18] To record his "real achievements," the accompanying two articles have been prepared by authors selected for their qualifying experience and professional standing.

I—TESLA'S CONTRIBUTION TO ELECTRIC POWER

CHARLES F. SCOTT
HONORARY MEMBER AIEE

FARADAY'S principle of electromagnetic induction discovered in 1831 after some 40 years of incubation resulted in practical forms of dynamo machines. Electricity from mechanical power (instead of costly batteries) stimulated invention of apparatus and the development of various methods or "systems" for distributing and utilizing the electric current. The evolution of "systems" culminated in Tesla's polyphase alternating current, with its unique induction motor. His system has dominated the development of electric service during a half century and continues today as our method of using electric power.

That was Tesla's contribution to electric power. Tesla's death in January last occurred in the semicentennial year of the demonstration of his polyphase system at the Chicago World's Fair and its adoption for the great Niagara project. It is the method in universal use today. We know no other. But the story of the pioneer years of electric light and power is needed to give perspective and reveal the real significance of the polyphase method.

After two score years, the dynamo; then in two eventful decades the trivial beginnings of the commercial electric light developed through the efforts of many workers and came to fruition in Niagara power, where the Tesla polyphase system achieved "the great step in the transition from mechanical power in industry to electric power everywhere"[1] and made possible our 20th-century power development. The years 1876, 1886, and 1896, serve as milestones marking these eventful decades.

1876

On Professor Elihu Thomson's 80th birthday anniversary (1933), I asked him just what electrical apparatus was at the Centennial Exposition in Philadelphia in 1876. "Well, I'll tell you," he said. "There was a Gramme machine from France that ran one arc lamp, and another wound for electroplating, and a Wallace dynamo that operated a lamp on top of the building." There was also at the exposition a dynamo designed by Professor W. A. Anthony.[2]

In 1928 the Franklin Institute celebrated the 50th anniversary of the first tests on the efficiency of a dynamo. Among the speakers were Charles F. Brush, whose dynamo was tested; Professor Thomson,[3] a teacher of science in the Philadelphia High School, who conducted the test; and his student assistant, E. W. Rice, later head of the General Electric Company. Brush, a Michigan graduate who had been keenly interested in the making of electrical apparatus from his high school days, had invented a new type of dynamo which could supply four arc lamps by four independent circuits, commercial sales of which had started early in 1878. He said, "It was in that year that I had the good fortune to invent and develop the modern series arc lamp with its regulating shunt coil. It made arc lighting from central stations commercially possible; and I think it may be regarded as marking the birth of the electric lighting industry." Dynamo and lamps were adapted to a con-

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Charles F. Scott, past president AIEE (1902–03), was with Westinghouse Electric Company, 1888–1911; then professor of electrical engineering (now emeritus) at Yale University. He was assistant to Tesla, 1888–89. In Tesla's original type of motor with primary coils around individual poles he effected radical improvement by devising a slotted secondary with specially distributed winding. Motors of this type (about five horsepower) successfully operated coal-mining machines as described in his paper in January 1891 before the Engineers Society of Western Pennsylvania, its first paper on mining. His AIEE paper describing two single-phase installations, for lighting at Portland, Oreg., and for power at Telluride, Colo. (for the latter he made the general plan) presented in June 1892 was the institute's first paper on long-distance transmission. He participated in planning and preparation of apparatus for the Chicago World's Fair and for the original hydroelectric development at Niagara Falls. His two-phase–three-phase transformer connection, more commonly known as the Scott T connection ("Polyphase Transmission," National Electric Light Association, March 1894), was used in the transmission of three-phase current to Buffalo from the original two-phase generators. He was technical advisor to Edward Dean Adams in his preparation of the two volumes "Niagara Power" and has made a special study of the state of the art in the period when Niagara plans were crystallizing. He was chairman of section *D*, electric power transmission, of the International Electrical Congress, St. Louis, Mo., 1904. His recent interest in electrical developments just preceding and during his own contact with them in the 1890 period have given a perspective view which he presents in the present paper.

stant-current series system; the usual current was about ten amperes, and the voltage increased about 50 volts as each lamp was added.

Following the Franklin Institute tests the Thomson–Houston arc-light system appeared; soon there were many others in vigorous competition for the lighting of streets and factories. To a limited extent motors were operated in series with arc lamps.

The constant-current (voltage varying with the load) system for operating motors is the method used in installations listed in Kapp's "Electric Transmission of Energy," 1890. Usually a generator and a single distant motor constituted the power transmission. At the Comstock mine in Nevada six 80-horsepower Brush motors received constant current over independent circuits from six generators and were belted to a single shaft for operating a stamp mill.[4]

Incandescent lamps could be operated on constant-current circuits if they had heavy filaments adapted to large currents and a few volts, or were connected in series-multiple. Practical difficulties inherent in the series connection were many. Edison saw the merits of a constant-potential circuit and the parallel connection of lamps, enabling them to be turned on and off like gas lights. He set about to make a high-resistance filament that would take a small current and thereby make possible conductors of permissible size. In 1879 he achieved a lamp and also the constant potential system which is the method in universal use today. His Pearl Street station in New York City opened September 4, 1882.

Ensign Frank J. Sprague, a few years out of Annapolis, was American member, and secretary of the jury of awards for electrical machines and lamps at the Crystal Palace Electrical Exhibition, London, 1882. In his elaborate report to the Navy[5] he describes about a dozen types of dynamos; evidently Edison's with "high-resistance" shunt field was the one particularly adapted to produce constant potential. Sprague says: "The Edison machines were designed to form part of a distinct and complete system of lighting and as such they possess some peculiar features not noted in other machines." In a paper before the British Association for the Advancement of Science on "Demands of a System of Electrical Distribution" he presents the new constant-potential system as best meeting these demands. In his painstaking report he describes many forms of arc and of incandescent lamps on exhibit, but no motors. There were none. On his return he pioneered the construction and introduction of motors on Edison circuits.

Electric cars were attempted by many pioneers in the '80's. Trial roads of a mile or so with one or more cars were followed by Sprague and his Richmond road calling for 40 cars, doubling the existing total in the United States.

1886

At Thanksgiving time in 1886 at Buffalo, N. Y. came a radical innovation—operation by alternating current. The new kind of current in small amount was transmitted at 1,000 volts and then transformed to 20 times the current for 50-volt incandescent lamps. While the Edison three-wire system was commercially limited by the cost of copper to about a half-mile radius, the new a-c system greatly extended the area that could be served.

Westinghouse had acquired the Gaulard and Gibbs alternating-constant-current system in 1885. At Pittsburgh what came from abroad was completely revamped, electrically and mechanically. William Stanley, the Westinghouse electrical expert, recognized the desirability of changing from constant-current to constant-potential operation; he was familiar with counterelectromotive force (he is said to have coined that term). His aim was a primary winding with sufficient counter electromotive force to permit transformers to be connected in parallel to a high-voltage circuit; for this he obtained an important patent.[6] Westinghouse, however, was concerned with securing a mechanical construction suited to manufacture. The form used in the early transformers was patented by him.[7]

The new transformer inspired confidence and Stanley proposed continuing the a-c development at Great Barrington, Mass. His successful demonstration of an operating system in March 1886[8] was followed by the design and manufacture at Pittsburgh of commercial apparatus and the inauguration of a-c service in Buffalo.

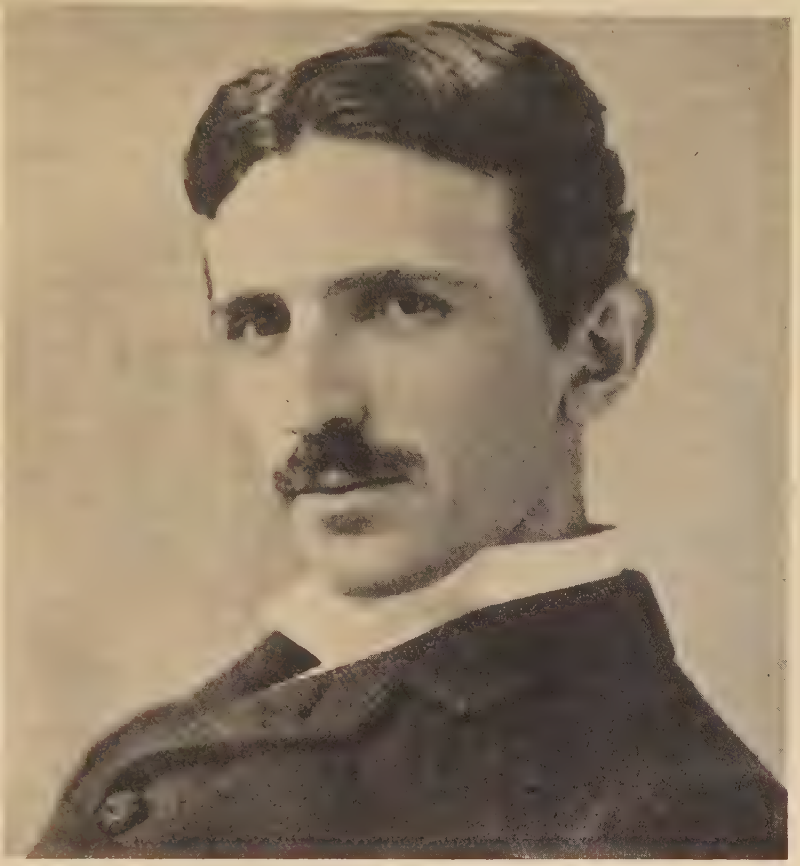
While alternating current overcame the distance handicap of direct current for incandescent lighting, it had no successful motor.

In May 1888 Tesla, in a paper before the American Institute of Electrical Engineers, announced his new system of a-c motors. In the new system polyphase currents produced in the motor a rotating magnetic field which induced currents in the closed motor secondary circuit, producing mechanical rotation. The rotative effect of alternating currents succeeding one another in time is analogous to two or three cylinders for producing continuous torque in an engine.

Westinghouse realized what this motor would mean for a-c service, and he acquired patent rights and Tesla's services. A serious situation was encountered. Commercial circuits were single-phase at a frequency of 133 cycles. Strenuous efforts to adapt the Tesla motor to this circuit were in vain. The little motor insisted in getting what it wanted, and the mountain came to Mahomet. Lower-frequency polyphase generators inflicted obsolescence on their predecessors in a thousand central stations—such was the potency of the Tesla motor.

The typical method of the '80's was the invention of a useful device such as an arc or incandescent lamp, or a railway motor, and the development of a "system" to operate it, which usually carried the name of the originator. In a decade there appeared a score of systems—technical or commercial—for each type of lighting and a dozen for street railways. The initiative lay with inventors and manufacturers; what they achieved was accepted and used. But in 1890 came a challenge to solve an unprecedented problem.

In our milestone year, 1886, a charter was obtained for a great power development at Niagara Falls. By the initial Evershed plan many canals at right angles from the upper river were to supply separate wheel pits, each with a 500-horsepower turbine which would discharge its water into a tunnel system terminating at the foot of the falls. The project floundered until taken up by a New York group which entrusted its development to Edward Dean Adams. It was soon found that the cost of the proposed excavation of wheel pits and discharge tunnels for water wheels at points along $2^1/_2$ miles of river front for the prospective industrial city would be far too great. Economy called for location of the water wheels at one point, but the production of enormous power at one point called for transmission both for local industries and for greater distances. Commercial electrical methods for arc and incandescent lighting either by direct or single-phase alternating current or for street railways when few electric machines exceeded 100 horsepower—all were inadequate for the great project. A world-wide quest for methods and apparatus was conducted by the International Niagara Commission of experts from several countries, headed by Lord Kelvin.[9] It invited and received plans. A copy of the original record of the commission in five volumes much in longhand—and 12 rolls of plans is in the Engineering Societies Library in New York. It shows the state of the art in 1890. The 17 projects from 20 representatives of six countries dealt with hydraulic equipment and with transmission. Of the best-presented plans for transmission, six were nonelectrical and four of these employed compressed air; of the six electrical plans, four used direct current. Typical of the latter was the connection of ten generators of 1,000 volts in series for 10,000-volt transmission to a similar arrangement of motors at Buffalo for driving generators for local distribution. Another plan proposed single phase, but "details were not fully described." The remaining plan by Professor George Forbes advocated a polyphase installation. He said: "It will be somewhat startling to many, as I confess it was at first to myself, to find as the result of a thorough and impartial examination of the problem, that the only practical solution for Buffalo and the best solution for the new industrial city which it is proposed to build near Niagara lies in the adoption of alternating-current generators and motors." He further stated: "The only nonsynchronizing motor which has been developed in a practical form is the Tesla motor manufactured by the Westinghouse Electric Company and which I have myself put through various tests at their works at Pittsburgh. . . . The torque on starting is considerable . . . the largest I have tested was five horsepower . . . they have no commutator or even brushes or other collectors." He proposed generators of 500 horsepower (in a 50,000-horsepower station) and transformers of 100 horsepower, as he advocated only sizes already assured.



Nikola Tesla in 1894

The commission found no proposal acceptable; "no prize was awarded for system of distribution"; it looked favorably on electrical methods but was not convinced that alternating current was adequate. (Lord Kelvin persisted in his opposition to alternating current until he was proved wrong by its successful operation.)

That was the status of power transmission in 1890, when construction of the tunnel for 100,000 horsepower was under way.

The polyphase system gained fame through the 100-mile transmission from Lauffen to the Frankfort Exposition in 1891 in which a 30,000-volt circuit delivered power to a 100-horsepower three-phase motor designed by Dobrovolsky. The project had been proposed by C. E. L. Brown, eminent engineer and designer, to test transmission at high voltage by bare wires. He comments: "The three-phase current as applied at Frankfort is due to the labors of Mr. Tesla."[10]

The Niagara project was alluring and the Tesla method promising. The leading American electrical companies, Westinghouse, Thomson-Houston, and Edison General, did not present plans in 1890. Shortly afterward, the latter two united in the General Electric Company, which continued the development of polyphase apparatus already begun by Professor Thomson. Westinghouse prepared for Niagara, delegating general engineering leadership to L. B. Stillwell and generator design to B. G. Lamme. As a preliminary, the lighting of the Chicago World's Fair, 1893, was undertaken by polyphase current. In an exhibit a 500-horsepower induction motor (pinchhitting for a prime mover) drove a two-phase generator for supplying power to motors and lamps, and, via rotary converters and motor generators, to all types of d-c operation—from one source all services.[11]

The Niagara engineers had invited proposals and, when the two American companies indicated their readiness to proceed, visits were made to their works early in 1893 to inspect apparatus and discuss plans. Following successive presentations from both companies, a contract was awarded in October 1893 to the Westinghouse company for three 5,000-horsepower Tesla polyphase generators—several times larger than any predecessor. (Later seven more completed the 50,000-horsepower equipment of powerhouse 1. The plans designated powerhouse 2 as "compressed air," but later it was electrically equipped by the General Electric Company.)

The simultaneous development of the Niagara project and the Tesla system was a fortuitous coincidence. No adequate method of handling large power was available in 1890; but, while the hydraulic tunnel was under construction, the development of polyphase apparatus justified the official decision on May 6, 1893, five years and five days after the issuing of Tesla's patents, to use his system. The polyphase method brought success to the Niagara project; and reciprocally Niagara brought immediate prestige to the new electric system.

Power was delivered in August 1895 to the first customer, the Pittsburgh Reduction Company (now Aluminum Company of America) for producing aluminum by the Hall process, patented in the eventful year 1886. Thus the demonstration of alternating current by Stanley, the charter of the power company, and the beginning of aluminum, all occurred in the early months of 1886. Each evolved in its own devious way and then joined in less than a decade in initiating a new era in power, in electrical service, and in the light metal.

1896

In 1896, transmission from Niagara Falls to Buffalo, 22 miles, was inaugurated. Compare this gigantic and universal system capable of uniting many power sources in a superpower system, with the multiplicity of Lilliputian "systems" which previously supplied electrical service. As Mr. Adams aptly explained: Formerly the various kinds of current required by different kinds of lamps and motors were generated locally; by the Niagara-Tesla system only one kind of current is generated, to be transmitted to places of use and then changed to the desired form.

The Niagara demonstration of current for all purposes from large generators led immediately to similar power systems in New York City—for the elevated and street railways and for the subway; for steam-railway electrifications; and for the Edison systems, either by operating substations for converting alternating current to direct current or by changing completely to a-c service.[12]

The culminating year 1896 inaugurated two far-reaching developments for the extension of polyphase power, one commercial and the other engineering. By exchange of patent rights, the General Electric Company obtained license rights under the Tesla patents, later made impregnable by nearly a score of court decisions. Also the Parsons turbine, accompanied by its foremost engineer, was transplanted to America and enabled George Westinghouse to bring to fruition by a new method the ideal of his first patent, a "rotary steam engine." The acme of the reciprocating engine came in the early 1900's; a century's development produced the great engines that drove 5,000- to 7,500-kw alternators for New York's elevated and subway. But the rapidly growing steam turbine of different types soon doomed the engine to obsolescence; single units with the capacity of a score of the largest engines are now supplying power to the metropolis.[13] Single powerhouses now supply more power than all of the thousands of central stations and isolated plants of 1890.

At the turn of the century George S. Morison, eminent engineer, heralded manufactured power—engine power—as "The New Epoch"[14] in human progress, most significant event since the invention of the written alphabet marked the step from barbarism to civilization. He reviewed the contribution of power to the industrial revolution and the 19th century development, notably through mills and factories, locomotives and steamships. He foresaw its accelerating expansion through new types of prime movers and electrical methods of distribution and application. Further, he indicated the profound influence of these physical agencies on our ways of life.

Much of what was predicted 40 years ago has already come to pass—including conflict and war. In our present strenuous war effort, both in the making of materials and in industrial production the sine qua non is electric power, and more electric power. The output of central stations during the first year of the present war was nearly ten times that of 25 years ago; it was greater than the immediately preceding year by 20 billion kilowatt-hours, the total output for the first year of World War I.[15]

Power and transportation have brought the nations of the world together as a unit. True, the development of physical facilities already moves faster than our ability to direct them to the social good. But the new epoch of power allows indefinite expansion in the progress of civilization and its contribution to the better life.

The coming of manufactured power marked the beginning of the new epoch in the progress of mankind. Electric power indefinitely amplifies the usefulness of mechanical power, through transmission and reincarnation in many motors, and by its production of light and heat and its contribution to chemical industry.

The evolution of electric power from the discovery of Faraday in 1831 to the initial great installation of the Tesla polyphase system in 1896 is "undoubtedly the most tremendous event in all engineering history."[16]

II—TESLA'S CONTRIBUTION TO HIGH FREQUENCY

L. P. WHEELER

DURING the early part of the last decade of the 19th century the attention of the whole scientific world was challenged by Nikola Tesla's public demonstrations of the effects of high-frequency alternating currents. It was then very early in the commercial age of electricity. The incandescent light had not yet become commonplace, electric traction was just being introduced, and the controversy over the relative advantages of the a-c and d-c systems was at its height. Tesla's own contribution to this controversy—one destined to be largely influential in the ultimate establishment of the low-frequency a-c system of distribution—was fresh in mind. The scientific world, stimulated by the brilliant investigations of Hertz in the latter part of the previous decade, was just beginning to adjust itself to the actuality of electrical effects at a distance without the use of wires and to the explanation of them as due to electromagnetic radiation. Further, it must be remembered that the beautiful and curious phenomena of conduction through low-pressure gases at that time had neither lost their novelty nor received any convincing explanation.

Thus the brilliant experimental demonstrations of Tesla in which the then customary limits both of frequency and voltage were far exceeded, coming at a time when the phenomena within those customary limits were not understood thoroughly, aroused extraordinary interest and stimulated research along several lines to a considerable extent. The lectures were literally as well as figuratively brilliant, as the effects of the high frequencies produced by his oscillation transformer were demonstrated chiefly by those luminous discharges in low-pressure gas tubes which may be regarded as giving the first impetus to the development of the modern methods of gas-discharge display lighting. By 1895 almost every physics laboratory in the country had built a "Tesla" coil, and much work immediately suggested by the lectures was under way. As far as the physicists were concerned, interest in such developments was, however, quite short-lived. This was due I think to two things:

1. There was a growing conviction (never shared completely by Tesla himself) that the distance effects were fundamentally attributable to electromagnetic radiation, and hence there was offered small hope of discovering any essential novelty. If there still remained some question as to the existence of some novel effect dependent on the very high voltages or frequencies or to their combination (a thesis maintained by Tesla himself throughout his life), the very general lack of existing equipment for dealing with the problems of insulation involved effectually discouraged any research in that direction.

2. That extraordinary series of discoveries (the electron, the X rays, radioactivity), which featured the second half of the 1890's and which almost overnight transformed physics from a striving for the next decimal place to an exciting exploration of new worlds, offered fields of research far more inviting and promising than that of high-frequency and high-voltage phenomena.

If, however, the lack of any effective follow-up of the Tesla phenomena on the part of physicists is understandable, it is more difficult to unravel the causes of the neglect of Tesla's procedure and devices in the commercial developments that followed, particularly those in the field of radio communication. One reason may lie in the fact that the industrial-research laboratory with equipment adequate to the problems involved was yet to be born. Another probably stemmed from Tesla's emphasis on the power rather than on the signal-transmission potentialities of his devices. The infant electric-power industry had too many difficulties on its hands in working out its destiny in the light of known principles and practices to spend much time or money or energy on totally untried projects or those involving little understood principles. Still another reason may be that the early successes of the Marconi and Slaby-Arco systems of wireless telegraphy without the use of the excessive voltages on which Tesla was so insistent, together with the (apparently) necessary connection

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L. P. Wheeler, is chief, technical information division, engineering department, Federal Communications Commission, Washington, D. C.; and president (1943), Institute of Radio Engineers. Doctor Wheeler graduated from the Sheffield Scientific School of Yale University (bachelor of philosophy, 1894; doctor of philosophy, 1902); and was a member of its physics staff from graduation until 1926. Three of his former students, DeForest, Hogan, and Van Dyck, are past presidents of the Institute of Radio Engineers. He had an active part in the organization of instruction in the Signal Corps School for Officer Candidates at Yale in 1918 and of graduate instruction in communications for Army and Navy officers, at Yale, 1919–26. From 1926 to 1936 he was associated with the United States Naval Research Laboratory, first as physicist, then as consulting physicist concerned particularly with radio communication. From 1936 to the present he has been with the FCC. He is coauthor of the book "Principles Underlying Radio Communication." One of his student predecessors as president of the IRE, J. V. L. Hogan, says of him: "There are few men as well qualified to appraise Tesla's contributions to today's high-frequency techniques. Being well grounded in basic physics, and having been engaged in instruction, university and governmental research, and administration, he is able to view Tesla's work with a perspective not available to those more closely associated with industry."

between relatively *low* frequencies and long-distance transmission, created the impression that Tesla's techniques had nothing to offer the new art.

As to his own development of high-frequency applications, it is apparent from a study of his patent specifications that, while he was perfectly aware of the possibilities of his high-frequency devices for space communications and understood that signals for this purpose might be propagated as electromagnetic waves (see, for example, the patent specification 613,809, of 1898), nevertheless he seems to have assumed that such propagation would be effective only for relatively short distances. He apparently thought that world-wide communications would be effected either by some form of corpuscular or electronic convection in the stratosphere or through the earth by alteration of its charge. If his knowledge of electrical science outside of the domains of a-c circuits had been more adequate, or if he had followed up experimentally the communication potentialities of his earlier inventions, his great talents would probably have led to much more fertile results.

Whatever may have been the cause, it is nevertheless the fact that, in comparison with the effect of his development of the induction motor on the electric-power industry, Tesla's contributions to the high-frequency field have been remarkably sterile. Of the well-known earlier treatises on radio, that of Fleming refers to Tesla's high-frequency alternator and oscillation transformer, those of Pierce and Zenneck refer only to the oscillation transformer among the Tesla inventions, and in any text published since about 1915 there is rarely even the mention of his name. The young radio engineer of today may very well complete his formal education without ever having heard of Tesla, except in connection with the induction motor and the rotating field, or possibly as the "father" of the neon-tube lamp.

This seems somewhat unfortunate, for a perusal of his pertinent patent specifications would appear to indicate that, although not exploited effectively for communication purposes, there are at least three matters of prime importance to the radio art today on which Tesla's ideas were clearer than those of his contemporaries and on which he is entitled to either distinct priority or independent discovery. These are:

1. The idea of inductive coupling between the driving and the working circuits.
2. The importance of tuning both circuits, that is, the idea of an "oscillation transformer."
3. The idea of a capacitance loaded open secondary circuit.

It seems incontestable that all three of these fundamental ideas are clearly revealed in Tesla's patent specifications and lectures prior to 1894, although their application to communication purposes, while mentioned, is made incidental to the power-transmission objective. As none of these ideas appear in the specific literature of the radio art prior to the patent specifications of Marconi, Lodge, and F. Braun of the years 1897–1900, it would seem that Tesla's name is worthy of perpetuation as a pioneer of these ideas which have been so basic in the radio art down to the present. He never succeeded, however, in translating these ideas into an operative system for the transmission either of signals or power. A study of the group of patents issued to him at the turn of the century would seem to indicate that he did not realize the importance of the effect of antenna capacitance on the tuning of its circuit. Thus his proposed system was highly inefficient, if not inoperative. Hence, while he fairly may be considered a pioneer of the fundamental ideas already mentioned, he cannot be rated as the progenitor of their useful application, except as his work was a stimulus to others.

In addition to this major pioneering activity, Tesla made at least two contributions specifically in the communications field that are not generally known. The first is that embodied in the patent specification 613,809, dated November 8, 1898 (application July 1, 1898), entitled "Method of and apparatus for controlling mechanism of moving vessels or vehicles." This method of remote control operates on a succession of radio impulses whose incidence on a receiving antenna energizes through relays the battery-powered steering and propelling motors of the moving vessel and whose sequency and duration (at the will of the operator) determine the direction and amount of rudder rotation.

The inventor states that any method of producing the radio impulses (whether invented by himself or others) may be used, and that their propagation may be by means of Hertzian waves or by the mechanisms (previously mentioned) that he favored. Without passing on the operative merits of the proposed system, it would seem to the author that this invention deserves mention as the earliest radio remote-control system with which he is acquainted. A minor matter of interest in this specification is the very ingenious decohering device employed—one quite different from those in common use at the time and perhaps more certain in its action.

The second of these less known contributions is contained in patent specifications 685,957 and 685,958 of November 5, 1901 (application March 21, 1901), entitled "Apparatus for the utilization of radiant energy" and "Method of utilization of radiant energy," respectively. These describe a scheme which, in so far as it would be actually operative, depends on the changes in the charge on a capacitor produced by the incidence of the radiation (light) on an elevated-capacitance plate antenna connected to one of the capacitor terminals. It is thus seen to embody an application of the photoelectric effect discovered by Hertz in 1887, although Tesla seems to have been ignorant of that fact, and the explanation he offers is largely fallacious. It is not necessary to go into any of the details of these specifications. They are mentioned here only as illustrative of the experimental keenness which independently rediscovered the Hertz effect and the ingenuity involved in finding a possible application for it. As far as the author is aware, this is the only suggestion of such an application on record.

After studying his patent specifications and the record of his public lectures, the author, in attempting to integrate and evaluate his impressions of Tesla and his work in the high-frequency field, has arrived at a mental picture of an immensely energetic personality possessing great skill in a-c techniques and great ingenuity in their practical utilization. There also emerges the image of a man unable to realize the limitations of his knowledge in other fields of science and the futility of mere ingenuity to overcome that handicap. These characteristics, combined with intense tenacity of purpose, resulted in the perversion of great talents into a largely unproductive direction. Nevertheless, his earlier accomplishments mentioned herein, together with the inspiration given to many through his public lectures,[17] would seem to justify a place in the history of radio engineering not so very far below that due to his accomplishments in the field of low-frequency alternating currents.

III—ADDENDA

TESLA'S EARLY PAPERS AND LECTURES

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1891——Experiments With Alternate Currents of Very High Frequency and Their Application to Methods of Artificial Illumination (AIEE lecture at Columbia University). *AIEE Transactions*, volume 8, 1891, page 267.

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1892 —Experiments With Alternate Currents of High Potential and High Frequency (Tesla's London lecture). W. J. Johnston Company, New York, N. Y., 1892. 146 pages. Out of print.

1894——The Inventions, Researches, and Writings of Nikola Tesla; with special reference to his work in polyphase currents and high-potential lighting, **Thomas Commerford Martin** (past president AIEE). 493 pages. Out of print.

1932——Nikola Tesla und Sein Werk, **Dipl.-Ing. Slavko Boksan.** Copyright 1932 by Deutscher Verlag für Jund und Volk, Gesellshaft M Blf, Vienna I Burgring 9. Printed in Austria, Buchrrucherei Carl Gerold's Sohn, Vienna, VIII, Hamerling, platz 10. 344 pages. An encyclopaediac treatise.

1936——Nikola Tesla—Memorandum Book on the Occasion of his 80th Birthday, Edition de la Société pour la Fondation de l'Institut Nikola Tesla. 520 pages, Belgrade, 1936. The sponsoring foundation was established by the government for research. Sixty delegates from scientific institutions in 13 foreign countries joined the officers and members of the Yugoslav nation in conferences at Belgrade, May 26 to 31, 1936, followed by one-day celebrations at Zagreb (University) and Smiljane (Tesla's birthplace). Subsequent meetings were held in Paris, Vienna, and other European cities. Papers are printed in the seven languages in which they were written. Tables and reprints add to completeness. Tesla is credited (1936) with 113 United States patents: polyphase currents, 41; high-frequency currents and high voltage, 29; wireless systems, 18; others 25.

Among Anniversary Greetings in the "Memorandum Book" are the following:

Robert A. Millikan: "When I was a student in Columbia University I attended a downtown public lecture in New York at which you made one of the first demonstrations of your Tesla coil and its capabilities. Since then I have done no small fraction of my research work with the aid of the principles I learned that night."

Arthur H. Compton: "To men like yourself, who have learned first hand the secrets of nature and who have shown us how her laws may be applied in solving our everyday problems, we of the younger generation owe a debt that cannot be paid."

Lee De Forest: "No one so excited my youthful imagination, stimulated my inventive ambition, or served as an outstanding example of brilliant achievement in the field I was eager to enter, as did yourself. Your simple statement that you knew I could succeed, renewed my courage and gave me new faith in myself at a time when I was sorely tried."

Gano Dunn: "My contact as your assistant at the historic Columbia University high-frequency lecture and afterward has left an indelible impression and an inspiration which has influenced my life."

D. McFarlan Moore: "You fanned into a never-dying flame my latent interest in gaseous conduction."

E. F. Northrup: "When I began to give consideration to electrical methods for melting metal, my mind at once went back to those early demonstrations by you and the electric circuits which you described."

Tesla said in his London lecture that his aim was "to advance ideas which I am hopeful will serve as starting points for new departures." His success is attested by his followers.

REFERENCES

1. Niagara Power—History of The Niagara Falls Power Company, 1886–1918.—Evolution of its Central Power Station and Alternating-Current Power System (two volumes), **Edward Dean Adams** (John Fritz medalist). Privately printed for Niagara Falls Power Company, 1926, Page ix.

2. On an Electromagnetic Machine Constructed at the Cornell University Work Shop, **W. A. Anthony** (Past president AIEE). *American Journal of Science and Arts*, October 1876, page 251.

3. Some Reminiscences of Early Electric Lighting, **Charles F. Brush** (Past president, AIEE. Edison Medalist); The Pioneer Investigations on Dynamo Machines Fifty Years Ago, **Elihu Thomson** (Past president AIEE; Edison medalist). Professor Thomson refers to assistance by one of his "most promising pupils." E. W. Rice (Past president, AIEE. Edison Medalist). *Journal* of the Franklin Institute, volume 206, number 1231, July 1928.

4. *Electrical World*, May 25, 1889, page 293.

5. Report on the Exhibits at the Crystal Palace Electrical Exhibition, 1882, **Ensign Frank J. Sprague** (Past president AIEE. Edison medalist). Navy Department, Bureau of Navigation, Office of Naval Intelligence, 1884. Washington Government Printing Office (His British Association for the Advancement of Science paper is on page 448 of its 1882 *Proceedings*).

6. Patent 469,809; **William Stanley**—"I conceived the idea of so proportioning the converter as to secure a variation of the counterelectromotive force in the primary proportional to the current abstracted from the secondary." Object, parallel operation. Specification for "Induction Patent," sent to attorney November 26, 1885. Application for patent, August 15, 1888. In interference with Slatterly patent 269,750, dated July 31, 1888. Patent issued March 1, 1892.

7. Patent 342,553; **George Westinghouse**—Transformer (*H* plate). Patent application made February 16, 1886; issued May 28, 1886. See Mechanical Development of Transformer by Westinghouse, **Charles F. Scott.** *Electrical Engineering*, December 1936, p. 1403. Contains description of the *H* plate, with drawing from patent. See also "Early Days of the Transformer," interview wih Reginald Belfield, *Electrical World*, November 1, 1930, page 918.

8. Early History of A-C System in America. **C. C. Chesney, C. F. Scott.** *Electrical Engineering*, March 1936, page 228. In the introduction we find: "As part of the Institute's celebration of the 50th anniversary of the establishment of the a-c system in America . . . the early history has been prepared by two past presidents of the Institute, both of whom were actively identified with the early development of the system." (Westinghouse, Stanley, Chesney, and Scott are Edison medalists.)

9. Niagara Power (see reference 1). The International Niagara Commission, Volume I; organization, page 181; report on projects, page 401. "Niagara Power" describes the evolution of plans and apparatus culminating in the adoption of the Tesla polyphase system. It elaborates many of the condensed statements in the present paper.

10. *Electrical World*, November 7, 1891, page 346.

11. Exhibit of Polyphase System at the World's Fair, **Charles F. Scott.** *Proceedings*, International Electrical Congress, Chicago, 1893, page 417. Published by AIEE, 1894.

12. New York Electrical Handbook (one of 11 handbooks). A guide for foreign visitors to the International Electrical Congress, St. Louis, Mo. AIEE, 1904.

13. George Westinghouse Commemoration. A forum on the 90th Anniversary (1936) of his birth. American Society of Mechanical Engineers. 78 pages; also *Mechanical Engineering*, April 1937. Includes contributions on the steam turbine by Keller, Hodgkinson, and Smith, and alternating current by Berresford, Stillwell, and Beardsley.

14. The New Epoch as Developed by the Manufacture of Power, **George S. Morison.** Houghton Mifflin and Company, 1903. 134 pages. Out of print. A recast of his presidential address (American Society of Civil Engineers), 1895, and other addresses. Reviewed by Colonel Prout in *Electric Journal*, September 1906, page 494; also in his "A Life of George Westinghouse," page 325. The latter recounts the development of alternating current, including the World's Fair and Niagara installations.

15. *Electrical World*, January 23, 1943, page 90.

16. Edwin H. Armstrong (Edison Medalist 1942) in a letter to the author commenting on a draft of, "Tesla's Contribution to Electric Power."

17. See anniversary greetings, in "Nikola Tesla—Memorandum Book on the Occasion of His 80th Birthday," listed under "Books."

18. Nikola Tesla. For items on presentation of Edison Medal, see *Proceedings* AIEE, June 1917, and current issues of *Electrical World* and of *Western Electrician*. A biographical obituary item appears in *Electrical Engineering*, volume 62, February 1943, page 76.

INSTITUTE ACTIVITIES

The Coming Year's Task—*A Message From the President*

I am taking this opportunity to express my deep appreciation of the great honor which the members of this Institute have bestowed upon me in electing me their president.

I realize the difficulty which any individual must experience in following the footsteps of many of my illustrious predecessors, but I am buoyed up in the knowledge that the accomplishments of the Institute do not rest so heavily on the president nor are they so much the result of his activities as they are the outcome of the co-operative effort of the great body of the Institute membership, ever striving to increase the excellence of the performance of our organization.

The Institute meetings and committee work have always constituted a forum for the exchange of ideas, and are more necessary today than ever, since the change to wartime economy has, of necessity, thrown many members into types of work with which they had no previous experience, and where they are frequently required to blaze pioneer trails. The ability to exchange ideas with those working in the same or an allied field results in a material speeding up of the effectiveness of all concerned.

Dependence should not be placed wholly on national meetings and national committees. The local Sections have a vital place in the program of helping the war effort, since they reach a much greater number of the Institute membership more frequently and are able by their efforts to provide effective help in their own areas.

The technical staffs of industry are composed of men with different types of engineering background—electrical, mechanical, civil, metallurgical, chemical, and others—and a great many of the current problems involve more than one type of engineering, so that there exists a need for the ability of the members of different engineering societies to discuss jointly the problems which lie across the fields of their respective knowledge. This field of joint activity on the part of the national societies should also be carried into the work of the Sections which can arrange for joint meetings with other engineering societies to discuss problems to their mutual advantage.

Some of the members of the Institute and some of the local Sections have suggested the desirability of curtailing the Institute's activities for the duration of the war, which to me seems to be diametrically opposite to what should be done. Mechanization has made this an engineers' war more than any before, and if ever the Institute is to give maximum help to the nation, now is the time. This is not an academic conclusion, but is supported by the very practical evidence that the attendance and interest in technical meetings is continually increasing. At the recent national technical meeting in Cleveland, even the last day, and through sweltering heat, the audiences at the technical sessions were unusually large and greatly interested—an evidence of the desirability of this type of meeting.

Nevin E. Funk, President AIEE 1943–44

The demands made upon our time because of present day conditions are a challenge to greater effort on our part to advance all phases of engineering activity.

N. E. Funk

National Technical Meeting to Be Held in Salt Lake City, Utah, September 2–4

A program designed to aid the war effort and to meet the needs of western engineers has been arranged for the national technical meeting to be held in Salt Lake City, Utah, September 2–4. Meeting headquarters will be in the Hotel Utah. The program comprises five technical sessions and three conferences.

In accordance with AIEE wartime policies as adopted by the Board of Directors all programmed social activities have been omitted. However, Salt Lake City is the center of the scenic West and is known for its hospitality. Members and guests will be most welcome, and there will be opportunities for informal get-togethers, visits to nearby mountains and canyons, as well as swimming in Great Salt Lake. Those desiring to participate should inquire at the registration desk.

TRIP TO UTAH COPPER MINE

In conjunction with the conference on metallurgy and the conference symposium on lighting a special excursion has been arranged for 2 p.m., Saturday, September 4, to the mine, mills, and smelter of Utah Copper Company. As copper is

Tentative Technical Program

Wednesday, September 1

2:00 p.m. Advance Registration

Thursday, September 2

9:00 a.m. Registration

9:30 a.m. Opening of Meeting

9:45 a.m. Theory and Machinery

43-137. Turn-Ratio of the Capacitor Motor. **T. C. McFarland**, University of California

43-136. Some Measures of Electrical Brush Disintegration. **M. S. Coover**, **E. E. Jones**, Iowa State College

43-138. Temperature Limits and Measurements for Rating of D-C Machines. **F. A. Compton, Jr.**, General Electric Company

43-144. Electronic Control of D-C Motors. **K. P. Puchlowski**, Westinghouse Electric and Manufacturing Company

2:00 p.m. Inspection of U. S. Bureau of Mines and University of Utah Laboratories

7:30 p.m. Conference on Metallurgy

CP.* Physical Aspects of Copper for Electrical Use. **P. H. Brace**, Westinghouse Electric and Manufacturing Company

CP.* Metallurgical Problems Arising From the Use of Copper in Electrical Equipment. **E. R. Parker**, General Electric Company

CP.* Metallurgy Production of Ferroalloys in Western States. **S. F. Ravitz**, U. S. Bureau of Mines

CP.* Production of Light Metals. **H. W. St. Clair**, U. S. Bureau of Mines

CP.* Quantitative Spectrographic Analysis. **Graham Marks**

7:30 p.m. Conference on Communication and Electronics

Address, "Electronics—A Tool for Industry." **R. H. Rogers**, General Electric Company

CP.* Use of Electronics in Metallurgical Research. **E. V. Potter**

Friday, September 3

9:30 a.m. Electrical Equipment for Military Aircraft

43-145. High-Voltage Ignition Cable Design for Aircraft. **H. H. Wermine**, Belden Manufacturing Company

- **ABSTRACTS of papers appear on pages 374–6 of this issue.**
- **PRICES and instructions for securing advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.**

43-140. Radio-Noise Elimination in All-Metal Aircraft. **Fred Foulon**, Douglas Aircraft Company

43-149. Parallel Operation of Airplane Alternators. **D. W. Exner**, Westinghouse Electric and Manufacturing Company

43-146. Aircraft Transformers—Small and Light. **O. Kiltie**, General Electric Company

CP.* Aeroplane Instruments. **R. L. Moeller**, General Electric Company

9:30 a.m. Selected Subjects

43-134. Effect of Frequency on Let-Go Currents. **C. F. Dalziel**, **Eric Ogden**, University of California; **C. E. Abbott**, Signal Corps

43-135. Effect of Wave Form on Let-Go Currents. **C. F. Dalziel**, University of California

43-139. The Automatic Welding-Machine Starter and Its Relation to Maximum Utilization of Power and Facilities. **N. E. Porter**, Permanente Metals Corporation

43-150-ACO.** A New Method of Measuring Contact Bounce. **P. H. Estes**, General Electric Company

12:00 m. Luncheon Conference for Students, Branch Counselors, and National Officers

2:00 p.m. Power Transmission

43-133. Lightning Surges Transferred From One Circuit to Another Through Transformers. **P. L. Bellaschi**, Westinghouse Electric and Manufacturing Company

43-151. The Effects of Mutual Induction Between Parallel Transmission Lines on Current Flow to Ground Faults. **J. I. Holbeck**, **M. J. Lantz**, Bonneville Power Administration

43-152. A New Simple Calculator of Load Flow in A-C Networks. **W. E. Enns**, Portland General Electric Company

43-141. Application of 720-Cycle Carrier to Power Distribution Circuits. **J. L. Woodworth**, General Electric Company

2:00 p.m. Conference Symposium on Lighting

CP.* The Historical Episode of the Lighting of the Mormon Temple. **S. G. Hibben**, Westinghouse Electric and Manufacturing Company

CP.* Saving Materials in Industrial Lighting Systems. **F. C. Winkler**, **H. G. Barnett**, Westinghouse Electric and Manufacturing Comapny

CP.* Uses of Electricity and Light in the Metal and Coal Mines of Utah. **T. A. Robinson**, United States Smelting, Refining, and Mining Company

CP.* Ultraviolet Light Sources in Analyzing Ores. **H. T. Plumb**, Consulting Engineer

3:30 p.m. Conference on Effect of Altitude on Rating, Testing, and Operation of Electrical Apparatus

CP.* Review and Discussion of Present Standards. **P. L. Bellaschi**, Westinghouse Electric Company

CP.* Recent Testing

CP.* Operating Experience. **L. W. Robertson**, Public Service Company of Colorado

Saturday, September 4

9:30 a.m. Student Technical Session

9:30 a.m. Protective Devices

43-147. A New-Type Carrier Relay Protection. **E. M. Wood**, Hydro-Electric Power Commission of Ontario, **F. A. A. Bailey**, Canadian Marconi Company, **H. W. Haberl**, Montreal Light, Heat, and Power Consolidated

43-142. Dethermalizing Arc Quenchers. **L. F. Hunt**, Southern California Edison Company, Ltd., **F. H. Cole**, Cole Electric Company

43-148-ACO.** Development, Tests, and Operating Record of the Dethermalizer Arc Quencher. **F. H. Cole**, Cole Electric Company, **C. P. Garman**, Bureau of Power and Light, City of Los Angeles

43-143. A New One-Cycle Directional-Overcurrent Relay. **W. C. Morris**, General Electric Company

11:00 a.m. Conference on Mining—Introductory to Afternoon Excursion

CP.* Utah Copper Mining

CP.* Copper Smelting

CP.* Uses of Electricity in Copper Mining

2:00 p.m. Special Excursion to Utah Copper Mine, Mills, and Smelter

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* CP: Conference paper; no advance copies are available; not intended for publication in *Transactions.*

** ACO: Advance copies only available; not intended for publication in *Transactions.*

Table I. Hotel Rates

	Rooms With Bath	
	Single	Double
Hotel Utah (headquarters) South Temple and Main Streets	$3.30 –8.00	$4.40 –10.00 6.60* –10.00*
	3.85**-5.50**	5.50** –7.50**
Newhouse Hotel Fourth South and Main Streets	2.20 –5.00	3.30 – 7.00
Temple Square Hotel West Temple and South Temple Streets	2.20 3.50	3.30 – 6.00

* Twin beds. ** With shower bath.

Other hotels with rates from $1.65 to $3.50 per day are: Semloh Hotel, Second South and State Streets; New Grand Hotel, Fourth South and Main Streets; Moxum Hotel, Fourth South and State Streets.

one of the most critical materials and the electrical industry was one of the largest users of copper, this trip should be most instructive. A first-hand knowledge of the industry, the physical properties of copper, and its uses, should aid the conservation of this critical material.

ADVANCE REGISTRATION

Members of Districts 8 and 9 and the nearby territory who receive the advance registration card and who expect to attend the meeting should fill in and mail the card promptly. A registration fee of two dollars will be charged all nonmembers except Enrolled Students and the immediate families of members.

HOTEL RESERVATIONS

To secure hotel accommodations reservations should be made as early as possible by writing directly to the hotel preferred. If assistance is desired, please write to C. A. Wolfrom, chairman, hotels committee, P. O. Box 899, Salt Lake City, 10, Utah.

COMMITTEE

Members of the national technical meeting committee making arrangements for the meeting are: A. L. Taylor, *general chairman;* L. D. Harris, *student activities;* A. C. Kelm, *finance;* J. A. McDonald, *publicity;* H. T. Plumb, *technical program;* C. A. Wolfrom, *hotels.*

Board of Directors Takes Action Opposing Kilgore–Patman Bills

Resolutions opposing the passage of the Kilgore–Patman bills were adopted by the board of directors of the AIEE at its meeting during the national technical meeting of the Institute at Cleveland, Ohio, June 21–25.

In brief, the Kilgore bill purposes the complete socialization of the scientific and technical resources of the nation, including all forms of property, methods, technical knowledge and data, and all personnel devoted to scientific and technical effort excepting physicians and dentists. Government control would be administered through a $200,000,000 bureau, and would extend beyond wartime into peacetime production. The Patman bill (H.R. 2100), its counterpart in the House of Representatives, is identical with the Kilgore bill in all important respects, and was considered jointly with it in the resolutions adopted by the board of directors.

These resolutions, prepared by the committee on research, June 22, and adopted by the board on June 24, 1943, are as follows:

1. *Whereas* the considered judgment of the Board of Directors of the AIEE, the national professional society of over 20,000 electrical engineers, is that the Kilgore–Patman bills S.702 and H.R. 2100 involve in their stated objectives research conducted by electrical engineers, and

2. *Whereas* the desirable objectives of the Kilgore–Patman bills are being attained by the Office of Scientific Research and Development, in co-operation with other agencies, and

3. *Whereas* the adoption of the Kilgore–Patman bills would tend to confuse rather than to clarify the present research programs, and

4. *Whereas* the research programs now in operation accomplish the desirable objectives of the Kilgore–Patman bills without the creation of an unnecessary governmental administrative organization, and

5. *Whereas* the concentration of great power in the hands of an appointed commission empowered to make restrictive regulations would tend to stifle rather than to promote creative research,

Be it resolved that:

1. The board of directors of the AIEE is strongly opposed to the passage of bills S.702 and H.R. 2100, and

2. These resolutions shall be published in *Electrical Engineering*, and the attention of Section officers shall be called to them.

3. Individual members of the Institute shall be urged to study the proposed bills to determine their effects upon electrical-engineering research, and

4. When invited by proper authority, the President of the AIEE is authorized to appear in person or by representative to explain further the board's position regarding these bills.

WHAT THE KILGORE BILL PROPOSES

Basic to the development of the senatorial bill is the establishment of a national scientific and technical office to integrate, initiate, and execute the purpose of the act as outlined in the declaration of policy.

This office, to be known as the Office of Scientific and Technical Mobilization, would be headed by an administrator appointed by the President with the advice and consent of Congress. A National Scientific and Technical Board and a National Scientific and Technical Committee would be set up by the bill, as well as a committee charged with maintaining the secrecy or restricted character of any information coming into the possession of the office.

The board's membership would be appointed by the President, and would consist of one representative each of labor, industry, agriculture, and the consuming public, and two additional members at large who would be scientists or technicians. The administrator would serve as chairman, and board members would perform such duties under the direction and control of the administrator as he might deem requisite to the successful operation of the office. The committee, an advisory group, would include the board members, four additional representatives of the consuming public, three additional scientists or technologists, six additional members each representing labor and management in the major fields of production and service, and one representative each of certain federal agencies designated by the President.

Automatically transferred, under the provisions of the bill, to the Office of Scientific and Technical Mobilization

An inspection trip is scheduled to be held September 1, during the AIEE national technical meeting at Salt Lake City, Utah, to this experiment station which houses the headquarters of the metallurgical division of the United States Bureau of Mines. Since most of the Bureau's stations primarily devoted to metallurgy lie west of the Mississippi River, division headquarters were moved to Salt Lake City when this station was completed in 1939

would be all the powers and personnel of the National Roster of Scientific and Specialized Personnel of the War Manpower Commission, together with its records, equipment, and all its unexpended balances of appropriations.

Through its administrator, board members, and other agents, the office would be empowered:

1. To maintain a census of scientific and technical facilities, requirements, and personnel in the United States and its possessions, and to provide archives for all scientific and technical material coming into government possession.

2. To develop comprehensive national programs for the maximum use of science and technology, in the national interest, in periods of peace and war.

3. To mobilize for the prosecution of the war all scientific and technical facilities and personnel.

4. To facilitate, after the war, the transition of national economy from the tasks of war to peacetime enterprise.

5. To formulate and promote projects and programs for the development and use of scientific and technical facilities and personnel and, when necessary, to initiate and carry out such projects.

6. To facilitate access to scientific and technical information, and to aid and encourage the writing and publication thereof.

7. To foster, develop, and finance scientific and technical methods, inventions, training and data to promote their application in the public welfare, and to promote and provide training and participation in science and in its application.

8. To help smaller businesses by making the benefits of scientific advancement available to them.

9. To discover and develop substitutes for strategic and critical materials, and to promote the most beneficial use of agricultural, mineral, and other natural resources.

10. To standardize, when in the public interest, scientific and technical designs, practices, and specifications.

11. To advise the President and Congress on scientific and technical matters.

12. To foster domestic and international co-operation in scientific discovery and technology.

13. To provide for occupational deferment of scientific and technical personnel when such personnel can be used best on the domestic front.

14. To establish a system of merit awards for outstanding scientific and technical contributions.

15. To initiate employment programs for voluntary participation of scientific and technical personnel in the war effort.

Some of the powers and duties implicit in the office could be exercised only when the nation is in an existing state of war or in a state of national emergency such as was declared on May 27, 1941. Such a power would be the authority to requisition, for suitable compensation, any scientific or technical facility or right, other than a patent itself, determined necessary for the defense of the United States or for the prosecution of the war. Another would be the authority of the administrator, subject to the chairman of the War Manpower Commission, to prescribe and promulgate appropriate regulations and procedures for the training, classification, and employment of all scientific and technical personnel until six months after the termination of war.

As regards patents, the office would be vested with the exclusive right to use, or to license others to use, any invention, discovery, patent, or patent right if the United States has contributed in any way to its development since May 27, 1941, or will contribute to it hereafter, or if, after the passage of the bill, it becomes to any extent government property. The office also would be empowered to acquire patents and patent rights and to authorize their use on a nonexclusive basis.

Among special privileges allocated to the administrator would be the power to create or to organize corporations as instrumentalities for the more effective exercise of his own duties or those of the office. In such an instance, he might make loans to, or purchase the capital stock of, any such corporation for any purpose within the powers of the corporation, provided the stock is owned only by the office.

Future AIEE Meetings

National Technical Meeting
Salt Lake City, Utah, September 2–4, 1943

Southern District Meeting
Roanoke, Va., November 16–18, 1943

National Technical Meeting
New York, N. Y., January 24–28, 1944

Ten Wartime Guides Presented at Summer National Technical Meeting

Wartime guides covering the application and operation of ten different types of electrical apparatus were presented at the AIEE national technical meeting, Cleveland, Ohio, June 21–25, 1943. As announced previously (*EE, June '43, p. 258*), the underlying theme of the guides is the conservation of materials through increased loading of equipment when conditions permit. Inter-American relationships also figured prominently at the meeting, being the subject of the general session at which two feature addresses were delivered, and of a conference at which informal talks were given on various aspects of the question, "How Can the Institute Render Greater Service to Its Latin-American Members?"

A total of 12 technical sessions and 10 technical conferences comprised the technical program of the meeting, as announced previously. This represents an enlargement compared with the 1942 summer meeting, in order to allow scheduling of as many subjects as possible related to war problems. There was standing room only at the two sessions on electrical equipment for military aircraft, demonstrating the intense interest in this subject at the present time. These two sessions were held Friday, the final day of the meeting, and many came to the meeting solely to attend those sessions. One conference was devoted to discussion of the engineer's interest in city planning, continuing the series of conferences on the general subject of civic affairs which have been held during recent national and District technical meetings. Two inspection trips, both related to conferences, were held; one to Nela Park, lighting division of the General Electric Company, where a conference on wartime lighting was held; and the other to the plant of the Ohio Crankshaft Company, where induction heating of metal parts was demonstrated. As all formal technical papers and approved discussions presented at the technical sessions will be published in the *Transactions*, no news reports of those sessions are included here. Brief reports on the conferences are presented in separate items, as they have become available.

Included on the meeting program were the usual items of the annual business meeting of the Institute and the annual conference of officers, delegates, and members. The latter comprised a combined morning session and two parallel afternoon "clinics" on the operation and management of larger and smaller AIEE Sections, respectively. Reports of these events may be found in separate items. There was one joint affair on the program, a dinner conference under cosponsorship of the AIEE and the Cleveland section of the Institute of Radio Engineers. An address, "Frequency Modulation Versus Amplitude Modulation at High Frequencies," was delivered by Raymond Guy, radio facilities engineer, National Broadcasting Company, New York, N. Y. F. C. Everett presided.

Meetings of several AIEE committees and subcommittees were held during the meeting week, as was also the regular meeting of the board of directors. At the latter, resolutions were adopted against passage of the Kilgore and Patman bills now pending in Congress (see separate item).

A total of 1,170 members and guests registered at the meeting, as compared with 1,179 at the 1942 summer meeting. Registration details are given in the accompanying tabulation. The meeting as a whole reflected the results of much careful planning and hard work on the part of the meeting committee and the various subcommittees handling the details.

COMMITTEES

The committee responsible for this year's summer meeting consisted of:

Wm. E. Wickenden, *chairman;* B. W. David, *secretary-treasurer;* G. R. Canning, *vice-chairman;* D Romadanoff, *secretary;* L. T. Blaisdell, P. L. Hoover. A. J. Kres, Mrs. A. M. MacCutcheon, D. E. Moat, E. A. Rossrucker, J. C. Strasbourger, and J. J. Tesar.

The general committee was assisted by the following subcommittees:

Finance: L. T. Blaisdell, *chairman;* B. W. David, *secretary-treasurer;* F. E. Cooper, H. J. Dible, Ward Harrison, W. C. Kalb, Wm. H. LaMond, A. M. MacCutcheon, and H. L. Wilcox.

Hotel: J. C. Strasbourger, *chairman;* L. C. Brewster, J. Jenkins, R. W. Loehr, C. C. McCall, and R. L Oetting.

Meetings and Papers: P. L. Hoover, *chairman;* W. C. Kalb, F. H. Knapp, J. D. Leitch, S. E. Leonard, and R. W. Loehr.

Publicity: E. A. Rossrucker, *chairman;* R. L. Oetting and C. F. Paulus.

Registration and Information: A. J. Kres, *chairman;* O. F. Ankenbrandt, A. F. Kunz, L. A. Neureither, W. R. Uffelman, and L. P. Winsor.

Transportation and Trips: J. J. Tesar, *chairman;* H. C. Bingham, A. D. Fishel, C. E. Ganther, F. W. Jackson, R. C. Putnam, G. B. Schneeberger, and J. L. Vergilio.

Annual AIEE Business Meeting

The annual business meeting of the AIEE held June 22 during the recent national technical meeting in Cleveland, Ohio, was the 60th annual meeting of the Institute, if we include in that count the organization meeting on May 13, 1884, declared President Harold S. Osborne, who presided. "During the past year the Institute has cut its activities very closely to the war pattern," he said. "I think that the very high level of activity under that war pattern," he continued, "has shown what a large amount the Institute has to contribute to the war effort." Following his opening remarks, President Osborne introduced Doctor William E. Wickenden (F '39), chairman of the general meeting committee and president of Case School of Applied Science, who extended the official welcome.

An unannounced item of the meeting was the introduction of Colonel John Millis (M '85), senior surviving member of the AIEE. He was among the first group of members elected (July 7, 1884) to the Institute after its organization. He is now retired and resides in Cleveland. After his introduction, Colonel Millis stepped to the platform and made a few appropriate remarks.

Included on the agenda were the annual report of the board of directors, the annual treasurer's report, report on election of officers (*EE, July '43, p. 313*), presentation of President's badge to President-Elect Nevin E. Funk, and the report of the committee on award of Institute prizes. Other features included an address on community planning, and presentation of the 1942 Lamme Medal to Joseph Slepian (A '17, F '27), associate director of research, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Excerpts from the former are given in succeeding paragraphs; essential substance of the medal presentation addresses is scheduled for publication in a later issue. The meeting concluded with the annual presidential address on the subject "Planning for Things to Come," full text of which appears elsewhere in this issue.

ANNUAL DIRECTOR'S REPORT

The annual report of the AIEE board of directors for the fiscal year ending April 30, 1943, was presented in abstract by National Secretary H. H. Henline (F '43). He called attention to the wartime policies adopted by the board last year and to the heavy emphasis, at the 1942–43 National and District technical meetings, on technical material contributing toward the war effort. Mr. Henline discussed also the activities of the various Institute committees and the manner in which their work is influenced by wartime demands.

The Sections held some 600 meetings during the year as compared with some 650 during the previous year. While this total represents a drop, it is a higher figure than for any year prior to 1937. Two new Sections were formed during the year, one in Montreal, Que., and one in Dayton, Ohio; the latter was first organized as a subsection of the Cincinnati Section to which it had been attached for many years. One new student Branch was organized, at Vanderbilt University, Nashville, Tenn., bringing the total number to 125.

Recent Summer-Meeting Attendance

1943	**Cleveland, Ohio**	**(2)**	**1,179**
1942	Chicago, Ill.	*(5)	1,173
1941	Toronto, Ont., Can.	(10)	1,204
1940	Swampscott, Mass.	(1)	1,010
1939	San Francisco, Calif.	(8)	945
1938	Washington, D. C.	(2)	827
1937	Milwaukee, Wis.	(5)	1,065
1936	Pasadena, Calif.	(8)	714
1935	Ithaca, N. Y.	(1)	901
1934	Hot Springs, Va.	(4)	350

* District numbers in parentheses.

A net gain of 1,217 members was reported by the membership committee, which is the largest for any year except one—1920–21. At the close of the fiscal year, the membership stood at 20,161 and by June 1 it had reached 20,298. Mr. Henline also called attention to other features of the report, including the financial report by the Institute's auditors. (As announced in the July issue, the full report is not being published in *Electrical Engineering* this year, but copies may be obtained by AIEE members upon request from AIEE headquarters.)

TREASURER'S REPORT

Total receipts of $391,948.41 for the year 1942–43, as compared with $344,910.88 for the preceding year, were reported by National Treasurer W. I. Slichter (F '12) in his summary report. Total expenditures for the two years were, respectively, $354,377.70 and $320,748.82. Mr. Slichter reported the total value of all reserve funds as $328,251.31, compared with $289,007.84 for the previous year. The book value of all securities he reported as $278,398.33 for the year just ended, compared with $225,220.33 for 1941–42; market value of all securities for the two years was given, respectively, as $275,195.03 and $203,652.82.

Analysis of Registration at 1943 Summer National Technical Meeting

Classification	Districts 1	2	3	4	5	6	7	8	9	10	Total
Members	105	404	82	21	126	4	25	8	7	23	805
Men guests	18	207	8	2	34		3	1		4	277
Women guests	4	53	9	3	15		2	1		1	88
Totals	127	664	99	26	175	4	30	10	7	28	1,170

PAPER PRIZES PRESENTED

P. L. Alger (F '30), chairman of the committee on award of Institute prizes, gave the report of that committee, after which prizes were presented to authors of the best 1942 national papers in various classifications. The recipients of these prizes were announced in the July issue (*page 314*) together with those awarded prizes by six AIEE Districts.

TOKEN TO TREASURER SLICHTER

Another unannounced item on the program was the presentation of a token of appreciation, in the form of an engraved certificate, to National Treasurer W. I. Slichter in recognition of his long and active service in the Institute. The occasion recognized the 25th anniversary of his election as an officer of the AIEE. In 1918 he was elected a manager; subsequently he served as vice-president (1922–24), and from 1930 to date he has served continuously as national treasurer. "Throughout that time he has served the Institute very actively," said President Osborne. "He has been on 34 committees, and . . . has a record of contribution to the Institute which is unparalleled in our organization and probably in any other. He not only has been on these committees but has served the Institute as representative on many boards." President Osborne then introduced Comfort A. Adams, who was AIEE president in 1918 when Professor Slichter was first elected an officer of the Institute and who delivered the following tribute to Professor Slichter.

"My duty is a very pleasant one. As we grow older, our perspective is apt to clarify and our sense of values to change. Thus, this simple and delightful act of honoring a beloved colleague becomes to me a symbol of national and international significance.

"Many of us have seen the world contract to a fraction of its size since we were children. In fact, our own profession, of which this Institute is the largest and most influential organized representative, has participated largely in that contraction, and we are apt to be very proud of that participation. However, one of the indirect results is by far the greatest war in human history. To me, at least, the lesson seems obvious, namely, that if anything worthy of the name of civilization is to survive, we must learn how to co-operate in a friendly and even generous fashion, rather than to fight blindly for material wealth without realizing the appalling price that we and many others must pay.

"This Institute is from one point of view a little world in itself, a world of friendly and nonprofit co-operation. It was organized to do an important job, to render an important service to its members and to society at large, but most of that service is not paid for in dollars. Fortunately, there are other types of reward which to many of us cannot be measured in dollars. In fact, most of the enduring satisfactions of life, including the most worth-while form of happiness, are of that type. Those who have come to a working realization of these facts are to be counted as fortunate, since the real reward is automatic.

"Thus, our Institute is a kind of training ground for co-operation or democracy, where we learn of the deep satisfaction of service and come to realize that our own welfare and happiness are largely dependent upon that of a host of others with the same goal in view.

"Although in these days some are inclined to scorn what they refer to as the 'old-fashioned code', it is still a fact that the satisfaction that comes from serving others, of even society at large, is immeasurably greater than that which comes from being on the receiving end in the material sense.

"In presenting this token we are honoring one of our most faithful servants—I like that word.

"As I look back over nearly 50 years of membership in our Institute, I recall no other who has given so much of his own time and so much valuable service over such a long, uninterrupted period. When I first knew Walter Slichter, he was a brilliant young designing engineer. Later, he became one of our foremost teachers of electrical engineering, and for the past quarter century, his continuously devoted service to our Institute has undoubtedly been a real factor in making it the greatest organization of its kind in the world.

"In addition, he has so endeared himself to every member of the Institute with whom he has come into intimate contact that we are all proud to call him 'friend.'

"The deeper my convictions, the more difficult I find it to do justice to them in words. What I wish most to emphasize is not the obvious material service, but rather the spirit of that service, which cannot be evaluated in words, but is instinctively felt by everyone who comes under its spell—the unostentatious spirit of cheerful service, of kindly human sympathy and fair play, which is more enduring and far-reaching than most of us realize. It is this spirit which gives us a spark of faith that those millions who are now paying the price of ignorance and greed may not suffer and die in vain."

After Doctor Adams presented the certificate, Treasurer Slichter responded briefly with appropriate remarks, expressing his deep appreciation of the token and his great satisfaction in having been of service to the Institute.

ADDRESS ON COMMUNITY PLANNING

One of the special events at the annual business meeting was an address on "The Fact Basis for Community Planning," by Howard Whipple Green, director of real property inventory of the City of Cleveland. In introducing his address, Mr. Green said that he would talk more about community facts than community planning These facts, he said, may be of several types, and he discussed four.

1. Those relating to the entire community—the population, how many people live here, how old are they, what is their sex and nativity, their race, their educational status, occupation, how many wage earners are employed in industries, the bank deposits' total, how many families have telephones, electric refrigeration, radios, how many of them are still in operation.

2. Those of historical nature, which show the trends over the years: How has population increased, or is it decreasing and to what extent? How does the value of manufactured products change? What is the rate of increase of kilowatt-hours of electricity sold? What is the change in the number of business telephones, the increase of service provided by public utilities, public transportation?

3. The general unrelated class including climate and rainfall, mortality rates, golf courses, parks, churches, schools, children, teachers, cultural institutions. In other words, what kind of place is it in which to live and to work?

4. Those relating to all of the three preceding classes, but which relate those items on a geographical basis.

Mr. Green devoted the principal portion of his address to the fourth class of facts mentioned. Oftentimes, he said, facts for the country as a whole are broken down into states or regions, cities or industrial areas, and into metropolitan districts or combinations of other areas. Likewise, the approach to a study of even so small a unit as the community is facilitated by dividing it into wards, boroughs, or precincts, health districts, school districts, or police precincts, or some other specially designated area. His recommendation for such a unit was the census tract.

The idea of considering communities in the light of census tracts, or geographically constant areas of approximately a half-million population, was first conceived by Doctor Walter Laidlaw of The Greater New York Federation of Churches, Mr. Green stated. Discovering that the only statistics published by the United States Bureau of Census available for the study of communities and neighborhoods were on a borough basis, and that each borough was larger than most entire cities in the United States, he proposed the idea of census tracts or sanitary areas. They were adopted by the Bureau of Census in 1910 for cities having a population of half a million or over.

Very little was done with these areas outside of New York City, however, Mr. Green continued, until 1926 or 1927, when Chicago and Cleveland at the same time became interested in the small areas. At the time of the 1930 census, 18 cities in the United States were laid out by census tracts, and by 1940, the Bureau of Census had approved 60 cities, and had assumed the responsibility of publishing at its own expense the data of these cities. Today, Mr. Green pointed out, such data are available in every city of the United States of over a quarter-million population and in some cities under a quarter of a million.

The chief advantage of using the census tract rather than wards, precincts, school districts, or other units, in studying a community is that the boundaries of the census tract are constant while those of the other areas change almost constantly. Theoretically, by the state law in Ohio, the wards change every ten years. As soon as the population becomes available by wards, there is an entirely new group of wards. The population that is served by a school district changes as new school buildings are built which cannot be moved or shifted around, so that census tracts are the only areas that maintain fixed boundaries.

The real property inventory of Cleveland has made use of census tracts in its survey of the community conducted annually since 1932. Each October, all the dwellings and nonresidential buildings in the community are visited to determine occupancy and vacancies, and to estimate the family count. New construction by year is determined by census tract, and sublotting activity has been studied by census tract yearly since 1802, when the first sites in Cleveland were laid out in real estate development.

The remainder of Mr. Green's address consisted of slides depicting various statistics for Cleveland by census tracts.

Sections Problems Dominate Conferences of Officers, Delegates, and Members

Reports of Sections activities during the past year and informal discussions of Sections' operating problems comprised the major portion of the conferences of officers, delegates, and members, held during the recent AIEE national technical meeting at Cleveland, Ohio. A series of scheduled talks and prepared reports occupied the attention of those at the Monday morning conference, which was the opening session of the meeting. In the afternoon two so-called Sections clinics were held, one for the larger Sections and the other for the smaller ones. Those from Sections having a membership of over 300 met in one group and less than 200 in the other group. Those from Sections having between 200 and 300 members had the choice of attending either.

Talks by President Harold S. Osborne, President-Elect Nevin E. Funk, and National Secretary H. H. Henline, were included on the morning program, in addition to a comprehensive report on Section activities during the past year with supplementary reports on some of the special projects undertaken by the Sections committee. An informal address entitled "I Am an American" added flavor to the conference in keeping with the times.

PRESIDENT'S IMPRESSIONS FROM VISITS TO SECTIONS

President Osborne reported that during the past eight months he had visited some

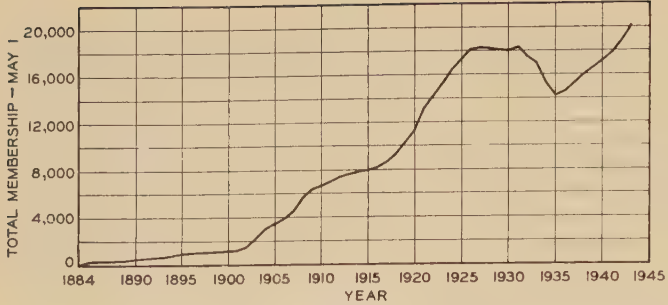

Figure 1. AIEE Membership

30 AIEE Sections and that he had been particularly impressed with the vitality of the work of the Sections and with the fact that they form what might be called both the heart and the backbone of Institute activities. About half of the meetings held during the past year have been closely related to the war effort, which includes about 25 per cent on conservation of materials and about 7 per cent featuring talks by men in the armed forces. "It is quite clear," he said, "that the Sections have been conscious of the war and that they have been adapting themselves well to the new conditions." He cited the formation of subsections and of an aircraft division in one of the Sections as illustrations.

One of the things that President Osborne reported as having impressed him most was the hearty co-operation between the Sections and other engineering groups, which he characterized as a very healthy sign. About a quarter of the meetings during the past year were joint meetings with one or more other engineering groups. He urged the Sections to consider during the coming year whether this percentage should not be increased because during wartime many subjects that will be discussed obviously will be of interest to other engineering groups. "Another phase of this co-operation," Doctor Osborne continued, "is the development of additional local engineering societies or clubs which represent all the engineers." He termed this one of the most effective ways in which engineers can achieve a greater participation in civic affairs.

DOCTOR FUNK SPEAKS BRIEFLY

At the conclusion of his talk, President Osborne introduced Doctor Nevin E. Funk, whose election as AIEE president for the ensuing year was announced the following day.

Emphasizing the value of experience in Sections work to those on national committees, Doctor Funk declared: "Like any democratic body, the Institute to function efficiently depends essentially on a very high degree of co-operation and the development of an understanding of the humanities in dealing with your fellow men. I think the best place to develop that is in the local Section meetings." Characterizing the majority of engineers as poor speakers, he also declared that the Sections provide very good opportunities for training in public speaking.

"AIEE BULLETIN"

Issuance of the first number of a new quarterly "AIEE Bulletin" for members in the armed services and the merchant marine was announced by F. A. Lewis, acting editor. He briefly described the content of the first issue and indicated the general direction of hoped-for development in succeeding issues (see announcement elsewhere in this issue).

"I AM AN AMERICAN"

A feature of the conference not directly related to the main business of the meeting but appropriate to the times was the talk entitled "I Am an American" by A. Boyajian (F '26), General Electric Company, Pittsfield, Mass. Constituting an extension of an earlier talk on the same subject (*EE, Dec. '42, p. 614*), Mr. Boyajian, himself an immigrant, said that while many a native-born American is proud of having a pilgrim in his family tree, many an immigrant American is proud of being a pilgrim himself. By a series of anecdotes he illustrated what Americanism means to these people, many of whom came to America to escape the tyranny of their mother countries.

INSTITUTE MEMBERSHIP AND FINANCES

Mr. Henline reported graphically on the status of the Institute's membership and its finances. His first slide, Figure 1, showed AIEE membership statistics on an annual basis from its organization in 1884 with 71 charter members to its April 30, 1943, total of 20,161.

As originally established, the AIEE had annual national meetings in various places, but little was done in the first decade and a half to expand the Institute throughout the United States. Efforts to establish regular and periodic local meetings as well as the annual national convention began to succeed about 1902, under the presidency of Doctor Charles F. Scott, as an ever-increasing membership pointed to their desirability. Doctor Scott also initiated arrangements for the local meetings of students in leading engineering schools throughout the country as well as for those older members already established in the profession.

By 1905, membership in the AIEE had topped that of any of the other three Founder Societies, a position it held until 1915. During the depression years, many members remained on the roll in an inactive status, by a special action of the Board of Directors. However, membership and finances slumped alarmingly, the former backsliding 22 and the latter 43 per cent. Our ranking position was forfeited but was regained and has been maintained since 1937.

On his second slide, Figure 2, Mr. Henline employed three curves, representing, respectively, receipts from advertisements and dues, and total receipts, per year. Revenue from advertising, first undertaken in 1922, rose gradually to the peak total of $85,000 per year, and then dropped abruptly during the depression. Dues maintained its level on a percentage basis much better than did advertising. Both are advancing now toward new peaks.

SECTIONS COMMITTEE REPORT

Chairman E. T. Mahood, reporting for the Sections committee, reviewed the manner in which the sixfold program adopted by the committee after its appointment last August had been executed.

One of the major determinations of the committee was the shaping of Section programs to the general pattern of the war effort. Two among the wide variety of programs on war subjects were specifically cited. The first of these was the program on the conservation of critical materials promoted largely by President Osborne and used by about 75 per cent of the Sections. Second, were the clinics relating to methods of improving production of war materials, sponsored by the War Production Board in many large manufacturing centers with the joint co-operation of the AIEE and other technical and engineering societies. The promotion of joint meetings to save time on the part of the engineers in the preparation of papers and in traveling was mentioned not only as contributing to the war effort, but also as a movement that may have lasting value to the engineering profession.

A second major aim was the development of South American Sections. Mr. Mahood reported the formation of a subcommittee, under the chairmanship of O. C. Brill,

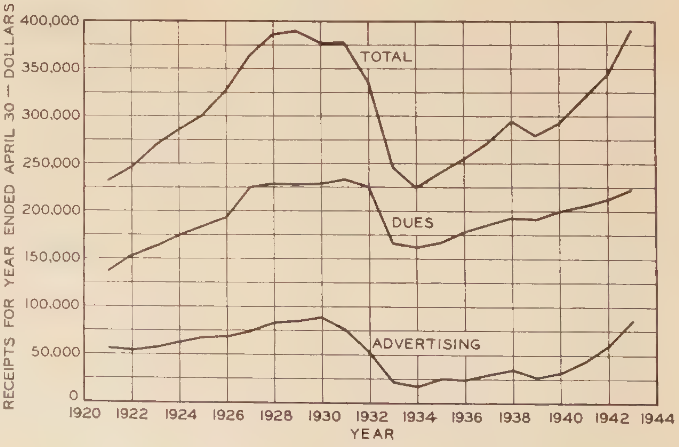

Figure 2. AIEE receipts

who has reported separately, to investigate and follow through proposals toward that end. An accompanying tabulation illustrates how widespread the AIEE membership is, and details the number of members in each of the various countries of South America. He quoted Mr. Brill as reporting sentiment in favor of forming Sections in Brazil, with 45 members, and Columbia, with 15 members. Others that might have possibilities are Argentina, with 29, Cuba, with 26, Puerto Rico, with 33, Chile, with 18, and Venezuela, with 15. Places like the Canal Zone, with 42, Alaska, with 13, Hawaii, with 38, along with Europe and Asia, are now so busy that the establishment of Sections will have to be deferred for a while.

Providing a vice-president especially to look after the interests of these 1,268 members (about as many as in the average District in the United States and Canada), to keep in touch with developments and possibilities in these countries, and to act as advisor to the Board of Directors on the special problems involved in financing and operating Sections in these countries, should be considered the logical preparation for extension of the Institute's help and influence in this direction, Mr. Mahood stated.

He then analyzed some of the financial aspects of the problem, his figures showing that the operation of foreign Sections would be feasible from this point of view if no travel allowance is made for delegates to attend the summer meeting.

At this stage in their development, plans for foreign Sections are merely recommendations of the Sections committee, Mr. Mahood stated, and are now being referred to the board of directors for consideration.

Another consideration of the committee was the assignment of territory to North American Sections. During the past year these changes have occurred:

1. Unassigned Nevada was divided between Utah, Los Angeles, and San Francisco Sections.

2. Unassigned Manitoba and Alberta Provinces were added to the territory of the former Saskatchewan Section, and the name changed to Mid-Western Canada Section.

3. A new Section was established at Montreal, Canada, with the Province of Quebec and part of Ontario as its territory and with a membership of 175.

4. A new Section was established at Dayton, Ohio, with about 95 members.

Only 51 members in the United States and Canada remain without Section affiliation, about half of these in Arkansas and half in the Maritime Provinces of Canada.

Foreign Membership, November 1, 1942

Mexico (1 Section)	63	Bolivia	8
Cuba	26	Brazil	45
Puerto Rico	33	British Guiana	3
Other West Indies	18	Chile	18
Bermuda	5	Colombia	15
Central America	18	Ecuador	2
Canal Zone	42	Paraguay	1
Alaska	13	Peru	7
Hawaii	38	Uraguay	1
Africa	52	Venezuela	15
Asia	290		
Australasia	112	Total South America	144
Europe	401	Grand total	1,268
Argentina	29		

Mr. Mahood proceeded with some interesting statistics on Sections, but was of the opinion that perhaps not many generalizations could be deduced from them since Sections and Districts must fit existing conditions within their limits. He suggested, however, as a Section objective of universal application the motto:

> "To have every qualified person in its territory actively at work to promote the Institute's objective."

A fourth aim of the committee was the development of subsections. Work on this objective was delegated to a special subcommittee under the chairmanship of E. W. Schilling, and was reported upon separately by him. Supplementing this report, Mr. Mahood suggested that the Institute can only represent the electrical engineering profession as a whole in large cities by providing facilities such as compact and active technical groups for every branch of electrical engineering. Geographical restrictions would be another reason for the formation of groups, or subsections, as in the following instances:

1. Small groups of from 8 to 10 members such as at Amarillo, Tex., and Shreveport, La., over 300 miles from Section headquarters, and with isolated members in the Section closer to them than to headquarters.

2. Larger groups of from 10 to 20 members such as at Nashville, Tenn., and Winnipeg, Canada, which are long distances from Section meeting places.

3. Groups of from 10 to 20 members somewhat closer to headquarters, but whose size may indicate the formation of a Subsection.

4. Groups of 20 or more members such as at Ottawa, Canada, or Tacoma, Wash., which are almost large enough to become full-fledged Sections, as was the case originally at Dayton, Ohio.

The collection and printing of additional data on Section operation and management, objective number five, was more or less subordinated to the aforementioned major efforts, Mr. Mahood continued, with the exception of the materials prepared for discussion at the summer technical meeting. The committee rested on the data widely disseminated as a result of a national survey of Sections conducted several years ago.

The remaining objective was the preparations for the summer technical meeting, supervised by J. M. Thomson and R. M. Pfalzgraff. Two "clinics" for the discussion of problems relating to Section operation and management were arranged, one for large Sections and one for small Sections. (Reports of both clinics are given in succeeding items.)

Mr. Mahood completed his report with a tribute to the service of the Sections and Section officers. Through their meetings, he said, the Sections are contributing distinctly to the prosecution of the war; they have been a source of inspiration to electrical engineers to design and operate equipment more effectively; and many lessons learned under stress of war will be of permanent value in the coming peacetime economy.

REPORT ON SOUTH AMERICAN SECTIONS

O. C. Brill, reporting on the activities of the subcommittee on the development of South and Central American Sections, declared it to be their foremost policy that any action taken by the Sections committee should arise from a manifestation of interest on the part of AIEE members in those countries directly concerned, and especially those members who are nationals of the countries in question.

This interest has been manifested, Mr. Brill related, both from the governments of these countries and from their nationals who are members both of the local engineering societies and of the Institute. They seem to be looking to the AIEE, as probably the largest engineering society in the world, to assume the leadership in laying the groundwork for international engineering co-operation and collaboration in the Western Hemisphere.

In addition to cementing further international relations, by expanding our foreign membership to include engineers of those countries who are eligible, the establishment of Sections in South and Central America, with all the privileges appertaining thereunto, would benefit those AIEE members who are citizens of the United States but who, because of the exigencies of their work, must live in other countries.

To supply a factual foundation to the overtures of interest made in this direction, M. S. Coover, past chairman of the Sections committee, was delegated with the task of writing to AIEE members of record and also prominent local engineers in these countries for their views. Mr. Brill, reported on behalf of Professor Coover, that the majority of these responses favored such an establishment and that many were enthusiastic endorsements with offers of positive help in getting such Sections started.

All of the replies from Brazil, which now has 50 members, were favorable, and included representation from both United States and Brazilian nationals. Major Carlos Berenhauser, Jr., a prominent Brazilian engineer now on extended visit to the United States, joined the Institute that he might give the project his active support. Some of the replies from Argentina, with the second largest membership of 31, expressed doubt as to the feasibility of operating successfully a Section in that country because of the other engineering societies now in existence there, but other members, both United States and Brazilian nationals, considered it advisable. Martin del Corral (M '24), president of Avianco, the Colombian national airways, on a visit to New York recently, suggested the formation of a Section in Colombia. There are 17 AIEE members in that country, all of whom have expressed their sympathy with, and avowed their support of such a proposal.

In the face of such evidence, the committee believes that present efforts should be concentrated on Brazil and Colombia, and that once Sections have been established in those countries, they will provide experience to guide further expansion elsewhere. Progress has been slow because of the time required for correspondence, but in both those countries preliminary organizational work is now in process and petitions for such Sections probably will materialize in the early future. However, one of the obstacles to be overcome in organizing Sections in Latin-American countries is the requirement in the bylaws that such a petition must be signed by 25 or more Institute members. Accordingly the committee has recommended to the board of directors that the bylaws be amended to reduce the requirement for signatures to a minimum of 15 members.

REPORT ON SUBSECTIONS

E. W. Schilling, reporting on the activities of the subcommittee on the development of subsections and technical discussion groups, declared that such action was more urgent than ever before now that travel restrictions were prohibiting members from driving the distances required to meet with their own Sections. He recommended that no energy be spared in organizing discussion groups, technical groups, or subsections, in order to prevent the rise of more specialized engineering organizations.

Many Sections have written that after a careful study of their own particular situations, the subsection idea is not adaptable to their needs. However, many letters have been received indicating that Sections are working on it and in some instances have already put them into operation (*EE, May '43, p. 218*).

A pamphlet has been prepared as a guide in the formation of subsections. This has been sent out to Section officers. Additional copies may be obtained by writing AIEE headquarters, 33 West 39th St., New York 18, N. Y.

Larger-Sections Clinic

Topics scheduled for discussion at the clinic on operation and management of larger Sections included: Section meetings, technical-group meetings, fellowship, financing District and national meetings, co-operation with war agencies, student activities, technical-paper competition, and related activities. The general plan followed in this clinic consisted in having an assigned delegate to open the discussion after which informal discussion by other delegates was solicited from the platform. G. W. Bower, chairman of the Philadelphia Section, presided, and A. C. Muir, secretary of the Philadelphia Section, acted as secretary. R. M. Pfalzgraff, member of the Sections committee, opened the clinic with an exposition of the clinic plan and the reasons underlying the holding of separate clinics for larger and smaller Sections.

President Harold S. Osborne pointed out that because of their greater numbers and resources the larger Sections have opportunities to do things that the smaller Sections cannot. He mentioned the opportunities that exist for the Section activities to serve as a model for the national organization; a successful Section activity might be desirable for ultimate adoption as a national activity.

Lead-off discussions on the various topics were given as follows:

Section meetings, A. C. Muir, Philadelphia Section.

Technical-group meetings, B. S. Cornell, New York Section.

Fellowship, L. F. Hunt, Los Angeles Section.

Co-operation with war industries, L. R. Gaty, Philadelphia Section.

Student activities, O. C. Rutledge, Schenectady Section.

Technical-paper competition, F. E. Keith, Chicago Section.

Membership transfers, R. G. Porter, Boston Section.

Publicity procedure, P. L. Hoover, Cleveland Section.

Instructional manual for Section officers, F. S. Black, Washington Section.

Participation in civic affairs, A. C. Muir, Philadelphia Section.

Discussion from the floor following these introductory discussions indicated that practices varied rather widely among the Sections in accordance with individual Section needs and preferences. The principal points brought out in the discussion are summarized in the following paragraphs.

SECTION AND GROUP MEETINGS

Most of the larger Sections have one or more organized technical groups called discussion groups, technical groups, divisions, or by other special names. Other Sections, particularly those covering large areas, have organized such groups on a geographical basis. The latter approach quite closely the form of the subsection, organization of which has been promoted during the past year (*EE, May '43, p. 218*). Among the newer groups reported as having been organized during the past year are one dealing with electrical problems for production foremen in the Philadelphia Section and an aircraft division of the Los Angeles Section (*EE, Apr. '43, p. 171*).

The majority of the larger Sections hold one regular Section meeting a month during the fall, winter, and spring months, at which a technical subject of broad interest is discussed. Supplementing these meetings, the various specialized groups hold meetings on more specialized technical subjects. In many instances attendance at the latter is reported as being on a par with attendance at the regular Section meetings. In Sections such as Michigan and Toronto, which cover large areas, meetings are held in the various cities of the Section territory; these are handled entirely by local committees.

Various degrees of joint activity with other societies were reported, but most of the Sections have at least one joint meeting a year. Most of the larger Sections also hold one meeting a year especially for students, at which prizes are awarded for student papers. Some of the Sections set aside one meeting as President's Night, and several invite the District officers to at least one meeting a year.

Meetings begin at from 7:00 to 8:15 p.m., depending on local conditions and needs. Some are preceded by business sessions, and in practically all instances the main event of the evening is followed by a discussion period. In some instances the meetings close with a period of social activities and refreshments. The Pittsburgh Section's student meeting is an all-day affair and includes inspection trips, a student meeting, and a dinner. Sections holding dinners preceding their regular meetings reported general success with this idea, but wartime restrictions are imposing difficulties here. Some Sections devote one meeting a year to a subject of interest to women, to which meeting they are invited.

Doctor Nevin E. Funk, AIEE President 1943–44, declared that the need for discussion or technical groups would increase, because the types of activity in electrical engineering are broadening all the time. The desirability of such groups increases as the size and diversity of the activities of the Section membership increase, he said, and the discussion group will be of material benefit in stopping the future branching off of some particular activity of electrical engineering into another specific national society.

FELLOWSHIP

Many of the Sections have reception committees which are charged with the duties of welcoming new members and guests at meetings and of helping the members to get acquainted. In some Sections, these committees also have charge of membership badges which are worn at all meetings; in some instances there are special badges for guests and new members, who receive special attention. In other Sections, the membership committees handle the so-called fellowship duties. In several Sections, either the membership or reception committee writes letters of greeting to new members and invites them to the meetings.

F. S. Black of the Washington Section said that the large number of visitors to that Section in recent years has created quite a problem. In addition to their regular reception committee, an associate chairman was appointed to contact members that have been transferred either temporarily or permanently to Washington. Meeting notices are sent to these individuals. The Section annually holds an outing which has proved highly successful, usually on a Saturday. Athletic events in the afternoon are followed by a dinner and evening program which includes installation of officers. Past chairmen are given special recognition at these outings.

A proposal to have a traveling representative associated with national headquarters to handle matters pertaining to the Sections was brought up and discussed. Reaction to this proposal as a postwar project was favorable.

FINANCING DISTRICT AND NATIONAL MEETINGS

The following recommendation was presented to the conference by the Sections committee for discussion:

> "It is recommended to each District which has not already done so that they consider establishing a permanent District fund by small annual contributions from the Sections for financing District and national meetings, so as to eliminate ultimately the necessity for asking for contributions from business firms, as in the past. Such a plan would put the Institute on a self-sustaining basis and make it much easier for small Sections to hold such meetings, and would tend to encourage Sections to undertake the work involved, and if this became a general practice it would be appropriate to put the funds in the hands of the District secretary who would thereafter become District secretary-treasurer."

A. C. Stevens, secretary of the AIEE North Eastern District, reported that such a plan has been operating in that District for 20 years and that it had been working very satisfactorily. Each Section in the District contributes a small amount to the fund annually, which has taken care of all needs so far. Other discussers favored the idea, but the difficulty of putting such a plan into operation, especially as far as the smaller Sections are concerned, was pointed out. No action was taken.

CO-OPERATION WITH WAR AGENCIES

Several delegates reported that their Sections had established special committees to co-operate with war agencies of one sort or another. Some of these committees have worked with the national committee on co-operation with war agencies, in handling locally assignments taken on by the national committee.

Chairman Bower reported on the war-production conference held in Philadelphia, one of the many such conferences held under joint sponsorship of engineering societies throughout the country. (Some of these have been reported in previous issues of *Electrical Engineering*.) As an outgrowth of that conference, a series of foremen discussion groups for production foremen was instigated as part of the war effort of the various technical societies in Philadelphia. The Philadelphia Section has taken the lead by organizing the first group and holding the first meeting. The meetings have been discontinued during the summer but will be resumed in the fall.

STUDENT ACTIVITIES

All of the larger Sections reported some activities especially for students. Usually, as already reported, at least one meeting is held especially for students during the season at which student papers are presented and prizes are awarded. In other instances efforts are made to stimulate student attendance at all Section meetings. Some Sections entertain the students at dinner preceding the students' meeting, each student being assigned to a regular Section member as host for the evening.

R. G. Warner, chairman of the committee on Student Branches, urged greater activity on the part of the Sections in connection with Student Branches during the coming year. He pointed to the uncertainties facing the Branches because of wartime conditions and urged Sections to take an active interest in providing speakers for the Branches.

Several other delegates reported that their Sections had established vocational guidance activities to aid boys in high schools who are interested in engineering as a career. Some of these provide speakers to high-school gatherings, and others contact the boys personally. One Section reported difficulty in carrying out guidance activity, because boys intending to study engineering need to decide before entering high school in order to choose the correct high-school course.

Doctor Charles F. Scott outlined briefly the student guidance work of the Engineers' Council for Professional Development, calling particular attention to the availability of Doctor William E. Wickenden's article "The Second Mile" which has been distributed widely *(EE, May '42, pp. 242–7)*.

MEMBERSHIP PROBLEMS

Delegates from some of the Sections spoke of the difficulty of retaining the interest of older members. It was considered important to retain the interest of the older members as an appeal to new membership prospects.

Section membership committees of most of the Sections are composed of representatives of each of the principal industries in the Section territory with one or two additional members to represent the smaller industries. The importance of appointing a well-qualified member as chairman of the membership committee was stressed.

Some Sections anticipate difficulty in getting new members, because graduating students that normally would be good membership prospects are now going directly into the armed forces. In this connection, however, Chairman Bower read a letter from John H. Pilkington, chairman of the national membership committee, which reported a net increase in national membership of 1,217 over last year and urged that Section membership committees work right through the summer so as to take advantage of war conditions which favor an increase in the membership.

R. G. Porter reported the procedures followed by the Boston Section in regard to transfers. The membership committee reviews the list of local members annually; these members are allowed to stay on the records for three years. If they are of engineering caliber and capable of going on to the Associate grade, they are strongly urged to transfer. The membership committee also urges Associates to transfer to Member grade if qualified at the end of six years. Transfers from Member to Fellow are handled by a committee composed of past chairmen of the Section which reviews the qualifications of eligible candidates and fills out the necessary forms to be forwarded to headquarters. In the St. Louis Section a committee is appointed in alternate years which considers all transfers to Member and Fellow grades and makes recommendations.

PUBLICITY

P. L. Hoover related how the Cleveland Section formerly spent from $200 to $300 a year for meeting notices. With the organization of the Cleveland Technical Societies Council a publication called *Cleveland Engineering* was instigated, in which notices of all technical societies in Cleveland are listed. These are sent to all members of all of the participating societies, and the cost to the AIEE Cleveland Section is from $25 to $30 a year, or about one tenth of the former cost. The Pittsburgh and Schenectady Sections handle meeting notices in a similar manner.

CIVIC AFFAIRS

The Philadelphia Section participates in civic affairs on a joint basis with other engineering societies through the civic affairs council of the Affiliated Engineering Societies of Philadelphia, said A. C. Muir. Discussion-group meetings on civic matters of timely interest are held. Meetings have been conducted largely as forums followed by free discussion; many of the speakers have come from some of the more active 85 civic organizations in Philadelphia. In connection with civic planning, Mr. Muir reported, this group has been instrumental in the formation of a planning commission in the city of Philadelphia, made up of men recommended by the civic affairs council and some others.

Similar participation in local civic affairs was reported by the Schenectady Section through the newly organized Schenectady Engineering Council through which the activities of local engineering groups in Schenectady are co-ordinated.

Among other topics discussed briefly at the clinic on larger Sections was a manual for the guidance of Section officers and reports of past Section chairmen to national headquarters and new chairmen.

Smaller-Sections Clinic

Principal topics discussed at the clinic on smaller Sections were Section organization, officers and committees, relations with headquarters, financial matters, Section meetings, programs, functioning of Section meetings, membership, and student relations. W. J. Gilson, vice-president elect, of Toronto, Ont., presided. Before discussion began, delegates from two new Sections organized during the past year were introduced: Frederick Krug of the Montreal Section and E. J. Bates of the Dayton Section.

J. M. Thomson, vice-chairman of the Sections committee, opened the discussion by explaining the general plan of the clinic idea and the factors underlying the splitting of the delegates into two groups, representing, respectively, the larger and smaller Sections.

SECTION OBJECTIVE

Discussion of this topic led to the adoption of the following resolution:

> "That an AIEE Section objective be adopted to read 'To have every qualified person in its territory actively at work promoting the Institute's objectives'; that the national secretary and national Sections committee be requested to obtain any approvals required, arrange to publicize this objective and develop plans for its effective use to promote Section activity including the compilation and dissemination of statistics which will give a better picture than is now available of how effectively each Section is carrying on the work of the Institute in its territory, with the hope that the influence of friendly rivalry between Sections as each strove to reach this objective may be brought into play as an effective force in promoting the Institute's work."

OFFICERS AND COMMITTEES

E. T. Pierson of the Lehigh Valley Section outlined that Section's procedure with regard to the selection of officers and committee chairmen. A list has been made of all members in the Section showing what committee activity or what office or committee chairmanship has been held. This list showed that some members had held some office or committee chairmanship for the past 10 or 12 years while other equally active members had seldom been on a committee or never held an office. Efforts will be made, he said, to put to work those in the latter group.

In the Rochester Section, according to Delegate R. A. Whitford, the nominating committee is instructed to nominate members from the leading industries in the city plus two members to represent members not associated with larger industries.

M. H. Pratt of the Syracuse Section described the revised election procedures adopted by that Section during the past year. He said that in previous years ordinarily only one member of the executive committee had had previous experience on that committee. The new rules provide for three holdover members out of a total membership of seven on the executive committee. Several delegates reported that their Sections had followed similar procedures for some years.

There was some discussion on the tenure and duties of the Section secretary, practice varying considerably. Several Sections reported that the secretary normally holds office for two years. Chairman Gilson mentioned that in the Toronto Section meeting notices are handled by a commercial organization. For a comparatively nominal fee, the organization has the notices printed and takes care of circulating them to the membership, thus simplifying the secretary's duties.

Chairman E. T. Mahood of the Sections committee urged that retiring Section chairmen prepare final reports on the work of the Sections during the year, these reports to go to the new Section chairmen, chairman of the Sections committee, and national headquarters. Chairman Gilson read a resolution prepared by Mr. Mahood covering this suggestion. The resolution, which was adopted, follows:

> "That it is the opinion of this group that it would be helpful to the Sections if arrangements were made to require the retiring chairman of each Section to make a report on the important developments which took place in the Section during his term of office and embodying recommendations for such changes, additions, or omissions in Section operation and management as his experience in office indicates would be beneficial to the Institute; copy to be sent to incoming chairman of Section, District vice-president, national secretary, and chairman of national Sections committee, for their review and action. With the establishment of this practice it may be possible to eliminate the notice and report on each Section meeting which is now sent to the chairman of the national Sections committee."

RELATIONS WITH HEADQUARTERS

First scheduled item to be discussed under this general topic was the matter of a manual on Section operation and management. The proposal was to have a manual prepared and circulated by National headquarters, perhaps in loose-leaf form, which would include all instructions and suggestions to Section officers in regard to the operation and management of Sections. These manuals would remain in possession of the Section secretaries and chairmen at all times and be passed from outgoing to incoming officers.

The discussion favored the production of such a manual and the following resolution was passed:

> "That it is the opinion of this group that it would be helpful and desirable for headquarters to supply to each Section two substantially bound copies of a manual on Section operation and management covering all pertinent features of Section operation, duties of officers, suggestions of national committees, and other material assembled for ready reference; arranged by numbered subjects in loose-leaf form so that revision can readily be made; one copy to be maintained by the Section chairman and one by the Section secretary; to be passed on to incoming officers to assist them in their work; and that some committee be established to develop the contents of this manual."

A resolution on Branch reports also was proposed, discussed, and passed, as follows:

> "That Branch reports in the future be sent to the national secretary, the District chairmen on student activities, the District vice-presidents, and the chairman of the national committee on Student Branches, but not to the chairman of the Sections committee."

The proposal to have a traveling AIEE representative associated with national headquarters to cover Section matters was discussed in some detail. Some delegates favored the proposal, expressing the opinion that such a representative would be very helpful to the officers of local Sections, whereas others thought the money required to employ such a man could be spent to better advantage in other ways. A recommendation that such a man be employed was shelved, finally, as the project did not seem feasible during the war.

FUND FOR DISTRICT AND NATIONAL MEETINGS

A proposal similar to that presented at the larger Sections clinic, that each District create a sum for financing District and national meetings, was discussed in some detail. R. G. Lorraine of the North Eastern District reported that such a fund had been operating satisfactorily in that District for some years. It has been the practice of that District in recent years to hold a technical meeting every year. Delegates from other Districts indicated that such a fund would have avoided some embarrassment over meeting deficits in the past. After further discussion the resolution was passed.

SUBSECTIONS

In regard to subsections, the Florida Section delegate stated that the subsection idea lends itself admirably to that Section. Subsections may be established in Miami, Jacksonville, and Tampa, and a meeting or two may be held by each of the three groups during the year. He suggested that the proposed manual of Sections operation and management be made available also to the subsections.

M. A. Faucett of the Urbana Section announced that that Section expects to organize subsections in Peoria, Springfield, and Decatur, Ill., during the coming year. The possibilities of subsections cooperating in joint activities with other engineering groups also was discussed.

PROGRAMS

The difficulty of the smaller Sections' getting good speakers for Section meetings occupied the principal attention of the delegates in this portion of the clinic. A proposal to establish a speakers bureau to aid in this problem led to passage of the following resolution:

> "That there exists a need for some better arrange-

In attendance at the AIEE national technical meeting in Cleveland, Ohio, June 21–25, 1943, were R. W. Gemmell, manager of aviation engineering, Westinghouse Electric and Manufacturing Company; Lieutenant Colonel T. B. Holliday (A '41), electrical engineer, United States Army Air Corps, Wright Field, Dayton, Ohio, chairman of the AIEE air transportation committee; and W. A. Mechesney, manager of aviation application, Westinghouse Electric and Manufacturing Company. Lieutenant Colonel Holliday presided at the two sessions on electrical equipment for military aircraft of the meeting

ments for making it possible for Sections to get in touch with persons who can make visits to various parts of the country to speak on Section programs, so that the programs of the various Sections can be better correlated with the traveling plans of such a speaker; that some definite channel should be established by action of the national committees to accomplish this either through a national officer or committee or through a District officer or committee. If done through a District officer, it is suggested that the duties of the District secretary be enlarged to include this function."

On this same general subject R. Felver of the Mansfield Section reported that the difficulty of getting expert speakers had led to scheduling a group of local members to speak at a meeting held by that Section during the past year on conservation of materials. He reported that the meeting was one of the most successful ever held by the Section and that the local speakers were found to be equally as good as those obtained from outside the Section. In view of this successful experience, the Section expects to have more meetings of that type. J. A. Northcott of the South Bend Section reported gratifying results with similar meetings in that Section.

A show of hands regarding the use of name tags at meetings showed that the majority of Sections do not use them, although several Sections reported highly satisfactory results in promoting fellowship by this means. Practically all of the Sections represented reported that attendance records are kept for Section meetings.

MEMBERSHIP

Various means of keeping the membership interested and active in Section activities were discussed. One means of stimulating interest among the older members reported by one Section was to ask some of the older members to contact other older members and ask them to attend meetings. Satisfactory results were reported.

The question of transfer fees was raised as being an obstacle to the promotion of transfers to appropriate grades of membership. H. H. Henline, national secretary, explained the reasons for the entrance and transfer fees. He pointed out that the reason for charging an entrance fee is that a person joining the Institute comes into an organization where he owns a share of the property, and assets of the Institute are valued at about $50 per member.

The question "Are all industries represented by membership as they should be?" brought forth some discussion on the matter of committee personnel. National Secretary Henline called attention to the stipulations of the bylaws in regard to committee appointments and said that efforts are being made to have committee membership distributed geographically as far as feasible, remembering that a committee must meet occasionally. In making committee appointments, he said, the President is guided largely by recommendations made by retiring chairmen of committees and by the Sections. Although all suggestions cannot be carried out, serious attention is given to them.

STUDENT RELATIONS

The clinic on smaller Sections closed with a discussion of student relations with the Sections. Chairman Gilson reported that one meeting a year is held by the Toronto Section in which four student papers are presented, two prizes being awarded. He reported highly satisfactory results with this annual affair. Students also attend the regular Section meetings, he said. Other Sections reported similar student relations.

R. G. Warner, chairman of the national committee on Student Branches, pointed out the difficulties expected for the remainder of the war in carrying on Student Branch activity. He urged the Sections to take active steps to help the Branches in any way possible, especially in obtaining speakers for Branch meetings. He suggested joint action on this problem with other engineering societies.

Inter-American Relations Subject of General Session

Attention was focused on the subject "The Engineer's Relation to Inter-American Affairs," at the general session held during the recent AIEE national technical meeting in Cleveland, Ohio. Feature addresses were delivered by: Major General Julian L. Schley, retired chief of the United States Army Engineer Corps, now director of transportation for the Office of the Co-ordinator of Inter-American Affairs; and R. E. Zimmerman, vice-president in charge of research and technology, United States Steel Corporation and president of the American Standards Association. A number of informal discussions rounded out the meeting.

In his opening remarks, AIEE President Harold S. Osborne said that the Institute has about 350 members in the Latin American countries, with one Section in Mexico, and that the establishment of Sections in South America is under consideration (see report of Sections committee elsewhere in this issue). Before introduction of the feature speakers, Captain B. H. Peake of the United States Marine Corps spoke briefly on the need for electrical engineers in the Marine Corps.

Addressing the session on the general subject of "Inter-American Affairs of Interest to the Engineer," General Schley spoke of the growing mutual confidence and understanding between the Americas, which is resulting in steadily improving inter-American relations. Declaring that "the electrical engineer has a very important stake in the progress of inter-American relations," he said, "the Americas are learning to work together for joint solution of common problems in an atmosphere of growing mutual trust. The many projects they are carrying on jointly today demonstrate the ability of the Americas to work together." Essential substance of General Schley's address is scheduled for publication in a subsequent issue.

Mr. Zimmerman in his address "Inter-American Co-operation in the Development of Standards," drew comparisons between previous international standardization activities with the European countries and those with Latin-American countries. He outlined the current progress of standardizing activities in various Latin-American countries. "A definite beginning," he said, "of the right sort we think has been made. . . . The American Standard Association, acting on behalf of its constituents, and with the indispensable assistance of its advisory committee on Inter-American co-operation, is making a determined effort to fortify and enlarge its initial undertaking, to the end that the opportunities now open in the field may be met, and that mutual good may result therefrom." Essential substance of Mr. Zimmerman's address also is scheduled for publication in a subsequent issue.

DISCUSSION

In the discussion period following the principal addresses, Major Carlos Berenhauser, Jr. (A '42), of the National Steel Company of Brazil reported on recent progress made by that company. "We already have in Brazil 20 blast furnaces in operation and we are rolling now, more or less, 350,000 tons of steel," he declared. All 20 of these furnaces use charcoal and have a comparatively small capacity, 50 to 100 tons per day. Studies now show that the grade of coal available in Brazil will produce good coke, and a blast furnace having a capacity of 1,000 tons per day and using coke is to be installed, he reported.

Commander T. F. Ball (F '38) of the United States Naval Academy mentioned the visits being made by representatives from Central and South America to the Naval Academy. He said that standards are uppermost in the minds of these representatives and that they are interested also in ordnance, seamanship, and navigation, but not to the same extent that they are in electrical and mechanical engineering. Another thing that they are deeply interested in is communication, he said, adding that "I believe that one of the best ways to build up good will is to have the proper form of communications among the Americas."

R. P. Crippen, international division, Ebasco Services, New York, N. Y., spoke on the human relationships entering into inter-American relations. He agreed with current reports to the effect that the feeling of friendliness between the peoples of North and South America has greatly increased recently, but urged that we "note what all of us as individuals can do." He stressed the importance of North American individuals, in their contacts with individuals of Latin-American countries, recognizing that those individuals are ordinary people like themselves and that they should be treated accordingly, not as specimens.

Stating that British and German standards had been powerful tools in getting business in Latin-American countries, J. B. MacNeill (M '36) of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., pointed out that those standards had been prepared from a point of view of selling equipment, which differs somewhat from the American point of view.

Most American standards have been prepared by people who are interested in the highest possible grade of service, and we may need alternate standards for export work, he declared. "The whole electrical standard situation has got to be changed to see if it is doing us the maximum good in international trade," he concluded.

Conference on Latin-American Relations

Supplementing the general session at the recent AIEE national technical meeting held in Cleveland, Ohio, was a conference devoted to the general question: "How Can the Institute Render Greater Service to Its Latin-American Members?" Several informal talks were given on various phases of the question, followed by open discussion. M. S. Coover (F '42), past-chairman of the Sections committee, presided. In opening the meeting, Professor Coover said that the nations of the North and South American continents already have recognized the need for closer collaboration on standards, and each has inherited therein real opportunities for significant technological and social gains in the years ahead.

Supplementing his address at the general session, R. E. Zimmerman, president of the American Standards Association, said that we now have an opportunity to do some of the things we should have done earlier in the direction of standardizing activities in the Latin-American countries, and emphasized the necessity of getting into a situation that is made to order. He stressed the importance of keeping standards and test codes dynamic rather than static.

The history of international standardization activities was outlined by L. F. Adams (F '42), General Electric Company, Schenectady, N. Y. He described first the International Electrotechnical Commission, organized in 1904, which had 27 member countries at the outbreak of hostilities in 1939. Three of these belong to the Western Hemisphere—Canada, Argentina, and the United States. Some dozen and a half standards have been produced by the IEC, but activities now are practically at a standstill because of the war.

The International Standards Association, Mr. Adams explained, is a federation of 20 national standardizing bodies, each of which is the central clearing house for industrial standardization work in its own country. The basis for the ISA was laid at an international conference in New York in 1926, and the American Standards Association joined in the fall of 1929. Activities of the ISA also have ceased because of the war. Although the name of this association implies an all-inclusive scope, Mr. Adams said, so far it has dealt mainly with mechanical subjects.

Alberto Magno-Rodrigues of the American Standards Association spoke briefly regarding relationships between Latin-American and the United States standardizing bodies, with particular reference to electrical standards. He pointed out that the American Standards Association has representatives in Argentina and Brazil, and he urged that the North-American countries help their neighbors to the South to achieve the same high standard of living that has come to be known as "the American way."

The status in Latin-American countries of technical books produced in the United States was outlined by W. S. Hall of the Henry M. Snyder Company, New York, N. Y., export representatives for American book publishers. He said that the demand for technical books is far greater than for any other type of books handled by that company. He reported a great increase in the sale of these books in those countries stating that the books have made a place for themselves by their form and content. As compared with French and German technical books, which had been used widely in Latin-American countries in the past, the North-American books are regarded as more modern and more practical. They are distinctly higher in price than the foreign books, a factor that was the prime deterrent to their sales before the war.

Regarding the technical-book situation after the war, Mr. Hull mentioned the following influencing factors:

"1. English is now the second language in Latin America rather than French.

"2. U.S.A. books are already strongly entrenched and have hurdled the difficult introductory period.

"3. Extensive industrial and engineering developments, in all of which American engineers are playing a leading part, lead naturally to a dependence on American books.

"4. The good-neighbor policy of our Government, intelligently administered in most respects, is showing results, and thousands of Latin Americans are buying and reading North American books who, five years ago, would not have touched one with a ten-foot pole."

In concluding, Mr. Hall urged that Spanish and Portuguese translation rights for technical books be released at as low a figure as possible and that some of our best-selling technical books be published in the United States in those languages under the original publisher's imprint. The actual printing of such books might be done in one of the Latin-American capitals, such as Mexico City, he suggested.

Major Carlos Berenhauser, Jr., (A '42) of the National Steel Company of Brazil commented on the application of North-American industrial equipment in Latin-American countries. He said that this equipment is better but costs more than equipment obtained from European countries, and that Latin-American countries do not have money to buy high-priced equipment. Industries in Brazil are not prepared to apply American standards directly, he said, but American standards can be used as a basis for the development of standards in that country. He predicted that the present inter-American co-operation will continue after the war and that the Latin-American market will not revert to European countries. In conclusion, he expressed the hope that a Brazilian Section of the AIEE eventually may be established.

Progress toward the formation of AIEE Sections in Latin-American countries was outlined by O. C. Brill, chairman of a special subcommittee of the Sections committee (details elsewhere in this issue). W. A. Del Mar (F '20) Phelps Dodge Copper Products Corporation, Yonkers, N. Y., offered the suggestion that the Institute solicit at least one Latin-American paper per year for AIEE meetings.

Major General Julian L. Schley, director of transportation for the Office of the Co-ordinator of Inter-American Affairs, supplemented his address at the general session with a few additional remarks at this conference.

Conference on Agricultural Electrification

A conference on agricultural electrification, featuring the presentation of five informal addresses, was held during the recent AIEE national technical meeting at Cleveland, Ohio. Because of the keen interest displayed in this subject, the conference, which began in the morning was extended into the afternoon for round-table discussion. W. F. Ogden, Jr., chairman of the AIEE committee on domestic and commercial applications, presided.

G. C. Neff (M '16), president of the Wisconsin Power and Light Company, Madison, in a historical review of the development of farm electrification, indicated the wide scope of future expansion of such a program. "It is my opinion," he said, "that rural electrification will not be producing full benefits to the farms of this country until some 4,000,000 of them are using an average of 500 kilowatt-hours a month."

The problem in making electric service available for farm operations, Mr. Neff explained, lies in maintaining the transmission system at a profit to both the farmer and the utility supplying the power. Farmers who think of electric service in terms of lighting only, and whose demands are not sufficient to support the cost of the lines, must be convinced by widespread and oft-repeated educational publicity that electricity must be applied to many more farm operations and the electric load must be increased if rural electric rates are to approach urban rates and if maximum efficiency is to be achieved.

The proper application of electric power to farm operations calls for a change in methods of farming, changes in farm management, and in the type and style of machines used. Operations which are now handled in urban centers could be handled on the farm profitably, such as processing of certain farm products, if proper machines and processes were developed. Labor can be saved since electric power can be operated for long hours under the control of automatic devices.

Mr. Neff recommended that the AIEE co-operate in a joint effort of farm and electrical groups to replace the Committee on the Relation of Electricity to Agriculture, which largely supervised this development from 1923 to 1939. He also recommended that the Institute or the American Society of Agricultural Engineers set up a system for gathering farm electrification data to be made available to farm publications.

F. E. Watts of the *Farm Journal* and *Farmer's Wife* discussed the part played by electricity as an economic and social factor in the evolution of agriculture from its days as an isolated economy to the development of chemurgy—the industrial utilization of farm products, which involves the growing of farm crops to specification. He specially emphasized the productive efficiency of electrified farm equipment, and pointed out the importance to postwar economy of extending electricity to the business of farming.

He divided the postwar era into three periods: (1) the relief period, when food must be quickly provided for millions of people already starving; (2) the period of rehabilitation, when occupied countries, as well as those of the United Nations must be provided with machinery and tools to revive their own agricultural production; and (3) the period of reconstruction, wherein agriculture will be developed through greater productive efficiency. "It is not only an opportunity but a responsibility of the entire electrical industry," he stated, "to devote to the fullest its research, its engineering, and its sales ability to the solution of a problem which so fundamentally affects the future welfare of the American people."

Ruggedness and reliability of operation, an investment cost–efficiency ratio that takes into consideration the low annual-use periods of much farm equipment; provision of large power units, or semiautomatic smaller ones with other advantages to offset bigness; and maintenance of a low service rate by keeping demand low and the load factor and diversity high—these are some of the requirements wherein design of farm equipment differs from that of urban machinery, G. W. Kable, editor, *Electricity on the Farm*, explained in his address on "Application Engineering—a Key to Farm Production."

Mr. Kable suggested that engineers would do well to seek out the farmers themselves as a source of ideas and accomplishment in the practical use of electricity on the farm, and then supply their own technical assistance in developing them. Especially do the farmers' needs as regards cost, simplicity, and function need to be observed. Such action would be mutually beneficial to the agricultural industry, he thought.

He illustrated his talk with charts showing the low saturation of farm appliances as contrasted with the saturation of home appliances, and others showing that the average annual farm consumption of kilowatt-hours was raised to the high level it has attained through the large consumption of a very few farms, or less than five per cent of the total.

R. E. Hayman, rural-electrification engineer, Oklahoma Gas and Electric Company, Oklahoma City, delivered a paper on "Progress in Serving Oklahoma Farms." With the aid of varied charts he reported on the development of rural electrification in his region since the formation in his company of a department exclusively for the investigation and promotion of rural activities until the present. He was able to show exceptional progress in load growth throughout progressive reductions in overall costs.

The conference on wartime influences on lighting filled this auditorium at Nela Park during the recent AIEE national technical meeting at Cleveland, Ohio. E. M. Strong (M '40) presided

In attempting to analyze the future direction of this development, Mr. Hayman stated that engineers or manufacturers of electrical machinery had not gone far enough in their adaptation of standard electrical equipment to farm use. He suggested that electrical farm equipment be designed and constructed with the purpose and the requirements of the specific farm operation in mind instead of being a general adaptation of equipment primarily designed for other purposes.

The production of food is only one of the farmers' responsibilities today, said R. G. East, general agricultural agent for the Pennsylvania Railroad, Richmond, Ind., in a discussion on "Chemurgy and What It Means to Electrical Engineers." Entire crops, in some instances, and by-products from many others are being utilized for explosives, paper, clothing, housing materials, insecticides, paints, synthetic rubber, plastics, and many other industrial products through the application of new scientific techniques and new forms of machinery. Mr. East outlined the rapid advance of this relatively new industry, and discussed its effect on future electrical equipment.

A brief description of the slide film, "The Care and Maintenance of Electric Farm Equipment," by A. H. Hemker of the rural electrification section of the General Electric Company, Schenectady, N. Y., concluded the conference. The film is available for demonstration but was not shown during the conference because of time restrictions.

City Planning Aired at Conference on Civic Affairs

Continuing the series of conferences at recent AIEE national and District meetings, a conference devoted mainly to city and regional planning was held during the recent national technical meeting in Cleveland, Ohio. James H. Herron, Sr. (F '41) president, James H. Herron Company, Cleveland, Ohio, presided.

A report on the conference on city and regional planning held during the North Eastern District technical meeting in Pittsfield, Mass., April 8, 1943, was presented by F. A. Cowan (M '29), vice-chairman of the technical program committee. In this report Mr. Cowan abstracted the following six addresses delivered at that conference:

1. The Engineer's Stake in Community Planning, **Harold S. Osborne**, President AIEE, 1942–43.
2. Regional Development Through Industrial Research, **Lawrence W. Bass**, director, New Industrial Research Foundation, Boston, Mass.
3. The Place of Planning in a World at War, **Elizabeth M. Herlihy**, chairman, Massachusetts State Planning Board.
4. City Planning, **Roger L. Putnam**, lieutenant commander, United States Naval Reserve (formerly mayor of Springfield, Mass.).
5. The Foundations of Postwar Planning, **William Stanley Parker**, consultant, National Resources Planning Board, Boston, Mass.
6. Some Planning Problems of the Postwar Period, **Frederick J. Adams**, associate professor of city planning, Massachusetts Institute of Technology, Cambridge.

Based upon these addresses, Mr. Cowan reached the following conclusions:

General Considerations

1. The end of the war will make available man power and material which can be applied to meeting the demands for goods and services which have necessarily been deferred because of the war.
2. The transition period from war to peace attended by the demobilization of the armed forces, release of labor from war work, and conversion of factories to peacetime production will create many problems in sustaining the national economy.
3. For this transition to be orderly, it is necessary to plan now for the immediate postwar period, taking a long-range view lest steps be taken as expedients which later may be causes of regret.
4. It is generally believed that both public and private enterprise will have responsibilities in the development of the postwar period and that each should prepare its own program with a full appreciation of the problems and responsibilities of the other. Only by a co-ordinated plan can long-range programs be carried out effectively.
5. Planning comprises the projection of the needs of a city or region into the future and deciding the best way in which these needs can be met. It involves the physical aspects of industry location, housing and transportation, and the economic, legislative, and administration aspects. There is also the equally important problem of gaining the co-operation and support of the public for any program which has been formulated.
6. Since future requirements and developments cannot be forecast accurately, a planning body should maintain close observations of the progress of the program and current trends modifying the program as required to meet changing conditions.

From the Engineer's Viewpoint

1. City and regional planning work should be of increasing interest to engineers first because their

responsibilities as citizens should urge them to make available to planning groups their training and experience and secondly, for the benefits accruing to themselves from close association with planning work in connection with day-to-day engineering and long-range programming in their private professional activities. Because of this dual stake, the engineer should take the lead in organizing planning activities.

2. Interest and participation in planning work implies that engineers keep themselves conversant with developments in scientific and technical fields, not only their own but others as well. While the professional societies have always afforded opportunities along these lines, they can become increasingly helpful by formulating programs emphasizing the engineer's role in planning work. The local engineering councils established in many cities, comprising professional engineers and members of the national engineering societies, have been very effective in assisting not only official planning bodies, but also industrial and private enterprises having a need for setting up long-range programs. Through the national societies, the activities of these local councils can be co-ordinated on problems national in scope.

3. In order that his participation in planning work will be most fruitful, the engineer will need to be well informed on the financial, legislative, and administrative phases of long-range programs and of local governments. To this end, the local engineering councils can be of great help in fostering an interchange of ideas between the engineers and the local administration.

4. In the field of public relations, the engineering councils will need by judicious publicity, contacts with newspapers and local radio stations, and other organized groups experienced in such matters, to draw public support to their activities and to encourage the communities officially or as individual members to avail themselves of the services of the councils.

Copies of the report (AIEE miscellaneous paper 43-122, "The Engineer's Interest in City Planning") are available by mail from AIEE headquarters at 20 cents each.

H. W. Green, director of real property inventory of the city of Cleveland, supplemented the address on community planning which he delivered at the annual meeting (see separate item) by additional data on this subject. He emphasized that planning must be timed properly, and that postwar readjustment must be made without the complication of widespread unemployment. The question as to what proportion of workers must be employed during the postwar period must be answered, he said, but the answer given now may not hold after victory. Other related questions are: What will happen to price ceilings? How many single women will continue working? How many married women will continue working?

Mr. Green also presented statistics on the educational background of people 25 years of age and over. Three times as many adults never went beyond the sixth grade as have graduated from college, he said, and those who never went beyond the eighth grade number four times the college graduates. Trained leaders must come from the educated groups, he said, which are being depleted by death and Selective Service. Calling attention to some of the difficulties of working with lawyers on civil committees, he urged engineers to *learn* community leadership. The engineer first must learn what is going on in the community, then determine his attitude on various questions, and finally decide what he should do.

J. T. Howard, planning engineer, city of Cleveland, outlined the benefits of city planning to the engineer. Stability of community areas and of taxation he indicated as the principal benefits to the engineer as a citizen. Advantages to industry are: co-ordination of the transportation system, stabilizing of residential areas and of taxation, and keeping labor reasonably happy. Mr. Howard pointed out that lack of planning had resulted in the wasting of many public and private funds in the over-expansion of suburban residential areas during boom periods. In conclusion, he said that community planning must have, and is acquiring, a scientific basis of operation.

In the discussion that followed, various questions were raised and were answered by one of the principal speakers. Mark Eldredge (F '33), War Production Board, Washington, D. C., pointed out that the session had been devoted primarily to the planning of new areas. What about old areas needing reconstruction? he asked. Mr. Howard replied that the redevelopment of old areas is one of the toughest problems facing planning agencies. He expressed the opinion that such areas must be redeveloped "by the square mile" and preferably by private enterprise.

A representative of the AIEE Philadelphia Section reported that that Section had been instrumental in forming a discussion group on civic affairs which later was expanded into a joint activity with other engineering groups in Philadelphia. Through this agency, civic problems have been brought to the attention of engineers, and the group has acted in an advisory capacity to civic authorities in the city.

War Problems Dominate Education Conference

Because of the new importance which servo-mechanisms, the basis of innumerable operations in our armed forces, have assumed, a talk covering their basic principles, fundamental definitions, and their classifications, by C. F. Green, aeronautic-marine department, General Electric Company, Schenectady, N. Y., was of special interest to the educators at the morning session of the conference on education held on June 24, during the national technical meeting.

Defining the servo-mechanism as an automatic control system which derives its control from a component part of the system actuated by some function of the difference, or so-called error, between the input signal and the output response of the system, Doctor Green arrived at these parts common to all servo-mechanisms: input element, error measuring element, control element, servo-motor, and the load. The servo-motor supplies the power for the output load and response. This power is controlled by amplification from the control element which is actuated through response from the error measuring element. The error measuring element receives the input signal, compares it with the output response, measuring the error, or its derivative, or its integral, functions. These error functions are combined in the control element and by this means the desired response of the system is brought into play through the application of various forms of control power. The control power may be hydraulic, amplidyne, thyratron, or multiple-contact. The closed system which characterizes servo-mechanisms means that the output response should possess the same rotational motion, displacement, voltage magnitude, speed value, and so forth, as the respective input signal quantity, and that the response is fed back to the error measuring element.

Animated cartoon movies, as a method of aiding students form mental concepts of a number of correlated simultaneous functions, were demonstrated by C. E. Gus, professor, New York (N. Y.) University. Professor Gus offered to assist anyone interested in using the easily prepared animated cartoons in teaching theoretical subjects.

An introductory talk on the psychology of learning and teaching under accelerated conditions, as in the military training programs, delivered by H. H. Davis, vice-president, Ohio State University, Columbus, was also part of the morning program.

The afternoon session of the conference was given over to a consideration of the many problems which have resulted from the Army and Navy Specialized Training programs. Many of the grave economic and administrative problems which have arisen for the colleges participating in the training program were discussed. Because of the lack of response to the call of the Army and Navy for trainees, the actual enrollment, in several instances, fell far below that promised to the colleges. Some courses were abandoned altogether. In addition the delayed response of prospective trainees caused the instruction schedules set up by the colleges to be ignored. In an attempt to dispel some of the existing confusion about the objectives of the training programs, Lieutenant Colonel F. H. Pumphrey (M '25) undertook definition of the Army's purposes while Lieutenant Commander T. F. Ball (F '38) presented the Navy's point of view. Colonel Pumphrey declared that the Army hoped the program would steer a middle course between "glorified job training" and "a super-engineering program." It wishes emphasis laid on imparting adequate basic theory of circuits, machines, and electronic apparatus. Instruction on the operation and maintenance of the highly complex types of Army field equipment will be given ASTP graduates at Army service centers. On the other hand, Commander Ball pointed out, the Navy, which has no corresponding service centers, would prefer that Navy trainees' instruction cover the operation of its specialized apparatus and the development of manual dexterity for "trouble shooting" and field servicing.

According to Colonel Pumphrey the Army is seeking to train two classes of men: noncommissioned officers whose responsibilities entail close supervision of the operation and maintenance of complicated field equipment, and officer personnel, capable of leadership, versed in the basic theory of the apparatus under their command, and possessing a working knowledge of its operation and field maintenance.

In regard to the teaching of servomechanisms in the ASTP, Colonel Pumphrey indicated that the instruction in this course would probably be limited to a few schools that were qualified by equipment and personnel for this particular type of work. (Robin Beach, chairman of AIEE committee on education.)

Conference on Teaching Ultrahigh-Frequency Phenomena

The conference on teaching of ultrahigh-frequency phenomena and procedures held during the summer national technical meeting was one of a series of such conferences since the original held at the Massachusetts Institute of Technology some time ago. The program comprised three scheduled informal talks which were followed by a general discussion. J. R. Martin (A '35) of the Case School of Applied Science, Cleveland, presided.

In the opening talk, J. G. Brainerd (M '39) University of Pennsylvania, Philadelphia, spoke of the mixed groups now taking military technical training courses in the colleges and of their varied educational backgrounds. Maxwell's equations, Bessel functions, and related matter can be given in the junior or senior year of an engineering course, he stated. Teaching the Fourier integral, however, requires more time. Professor Brainerd also drew some comparisons between the meter-kilogram-second system of units and other systems, from the standpoint of their usefulness in the ultrahigh-frequency field.

Calling attention to the differences in fundamental concepts involved, H. J. Reich (A '32), University of Illinois, Urbana, pointed out the difficulty of introducing ultrahigh-frequency courses into so-called power courses or regular electrical-engineering courses. Trigger circuits, cathode-ray circuits, and similar applications in the electronics field have been worked into the present ultrahigh-frequency program. A student who has studied the ultrahigh-frequency fundamentals and electronics can handle the Klystron and related equipment satisfactorily but will not be exactly an ultrahigh-frequency specialist. In regard to the postwar situation, Professor Reich said that we must continue to teach fundamentals and not attempt to cover the many ultrahigh-frequency applications in detail.

Ultrahigh-frequency laboratory problems were discussed by W. C. Osterbrock (M '41), University of Cincinnati, Ohio. He said that a committee had been appointed to establish designs for ultrahigh-frequency laboratory equipment, but that so far the committee had not functioned. The problem, therefore, was left to the schools, and the schools had improvised laboratory equipment under some difficulties. He called attention to the scarcity and difficulty of obtaining equipment and the confusion encountered with suppliers as regards priorities and other wartime restrictions. He emphasized the importance of a thorough grounding in the practical handling of equipment but reported that the teaching of these aspects varies among the schools. Among the experiments prescribed at the initial MIT conference, those involving directive antennas have proved the most difficult.

In the general discussion, Commander T. F. Ball (F '38) of the United States Navy declared that the Navy needs men who both understand and can operate equipment. Stress fundamentals first, he urged, but also show the men how to operate the equipment.

Lieutenant S. G. Reiches of the United States Army described the operation of radio locaters (radars) in England. Women handle the actual operation and the minor servicing of this equipment, while the administration is handled by men. The administrative personnel know the fundamentals of ultrahigh-frequency phenomena and their application to radio locaters but do not perform operation or maintenance duties. He emphasized the fact that operation counts in the field, not theory.

Conference on Safety

The fundamental problems of safety are the same whether an organization be large or small, but the methods of approach in solving these problems must be adapted to the size and type of organization. A high degree of safety can be achieved in the smallest enterprise if the management will inculcate safety training along with other operational teaching activities, and if the responsibility for safety efforts be placed with the supervisory force in addition to their regular duties. Such were the conclusions derived from the conference on safety, held during the recent national technical meeting in Cleveland, Ohio, June 22. Frank Thornton, Jr. (F '21), chairman of the AIEE committee on safety, presided.

O. S. Hockaday (M '28), superintendent of transmission, Texas Electric Service Company, Fort Worth, presented the main paper of the session, "Practical Accident Prevention in Small Groups." Two prepared discussions followed his paper, the first by S. B. Taylor of the Reliance Electric and Engineering Company, Cleveland, Ohio and the second, "A Practical Safety Program for the Small Plant," by J. G. Jackson (A '08), director of engineering, Square D Company, Detroit, Mich. Open discussion concluded the program.

Student Branch Counselors Confer at Technical Meeting

The combining of Branch and subsection activities in regions where such an arrangement would be a greater convenience for members who might otherwise have to travel long distances to participate actively in Section affairs, was recommended by E. T. Mahood, chairman of the AIEE Sections committee, in his opening remarks at the conference of Student Branch counselors held June 23, during the Cleveland technical meeting. In addition, he suggested that should this arrangement be adopted, financial assistance be given to the subsection by its Section.

Proposals to differentiate between part-time and full-time graduate students and to lift the five-year limitation on enrolled students were submitted to the conference by P. C. Cromwell, chairman of a special subcommittee on graduate student enrollment. His report advised that part-time graduate students who are working as engineers are suitable candidates for associate membership. However, the report advocated that full-time graduate students with more limited incomes be given an additional term of from two to four years as enrolled students. The report was adopted by the conference and recommended to the board of directors for further action.

Discussing the development of professional consciousness among engineers, C. F. Scott (HM '29) professor emeritus, Yale University, New Haven, Conn., requested that the Branches aid in fostering a professional attitude among students. He urged that more students familiarize themselves with W. E. Wickenden's "Second Mile," (*EE, May '42, p. 242*) as a step in this direction.

D. C. Jackson (F '12) professor emeritus, Massachusetts Institute of Technology, Cambridge, reported on the progress of the engineering code of ethics recently completed by a special committee of the Engineers Council for Professional Development. The code was approved by the Council at its 1942 annual meeting for submission to the boards of directors of the participating societies. Doctor Jackson defended the code of 31 items against charges that it is too lengthy, pointing out that in 1908 the lawyers drew up a code of 32 items which has since grown to 46. The conference voted to appoint a committee to bring the subjects of engineering as a profession and the professional code of ethics to the attention of the Student Branches. The committee appointed was: W. H. Gamble (M '33), South Dakota State College, Brookings, *chairman*, A. J. B. Fairburn (M '34), University of Akron, Ohio, and E. M. Strong (M '40), Cornell University, Ithaca, N. Y.

As chairman of the subcommittee for maintaining contact with students in the armed forces, E. M. Strong announced that an AIEE *Bulletin* containing, in condensed form, material from the news section of *Electrical Engineering* had been printed and mailed to members in the services (see page 374).

E. W. O'Brien (M '37) chairman of the subcommittee on student prizes presented a report recommending that student prizes be established for each District. These would be awarded at the closing session of the conference, convention, or regional meeting at which the District paper presentation contest takes place. First prize would be $25, second $25, third $15, and fourth, $10. The conference accepted the report and recommended its adoption by the board of directors.

In the general discussion following the scheduled business of the conference, Lieutenant Commander T. F. Ball (F '38) recounted his experiences, at Annapolis, with a "clinic" where a new group of 300 engineering graduates of schools throughout the United States is received every 16 weeks. From the average group about 10 per cent can pass an examination on elementary work in circuit theory and machines, while one third can pass an examination covering the fundamental courses of physics, chemistry, and mathematics. After a one-month refresher course 103 out of one group of 300 passed a test in these fundamentals and 27 of the 103 passed a test on elementary electricity. Numerical mistakes accounted for a large number of the failures. Commander Ball pointed out that instructors at the Naval Academy must now be graduates of accredited engineering schools.

Robin Beach (F '35), Polytechnic Institute of Brooklyn, informed the conference that a bulletin on movies available for Branch technical meetings may be had at AIEE Headquarters. Chairman R. G. Warner of the committee on Student Branches presided.

AIEE Issues "Bulletin" for Members in Armed Forces

First issue of the AIEE *Bulletin*, a four-page 8½- by 11-inch quarterly publication for AIEE members in the armed services and the merchant marine of the United States, has recently been completed and mailed. The second number is expected to be issued in September.

Designed to reach all members in the armed forces who are unable to receive *Electrical Engineering*, the *Bulletin* is comprised of condensed news items on Institute activities and on the related developments on the home front of interest to them as engineers. Members can co-operate in this wartime enterprise by sending in items of interest to those in the services and by keeping Institute headquarters informed of their latest addresses.

SECTION

New AIEE Section at Dayton

The new AIEE Section at Dayton, Ohio, comprised of three counties released from the Cincinnati Section and five counties from the Columbus Section, held its organizational meeting June 15, 1943. Formation of the new Section had been authorized by the executive committee at its meeting on May 27.

Section bylaws were adopted and the following officers were elected for 1943–44:

Chairman—L. J. Fritz (M '42) district plant engineer, Ohio Bell Telephone Company.

Vice-chairman—E. R. Martin (M '31) American Aircraft Manufacturing Company.

Secretary-Treasurer—J. W. Gehrke (M '41) distribution engineer, transmission and distribution engineering department, Master Electric Company.

Assistant Secretary-Treasurer—F. S. Himebrook (M '39) electrical engineer, Master Electric Company.

Directors—J. M. Coombs (A '41) and E. J. Bates (A '43) National Cash Register Company; H. E. Deardorff (A '37) supervisor, system planning engineering, Dayton Power and Light Company; W. A. Dynes (A '35) chief electrical unit, specifications branch, materiel division, United States Army Air Corps, Wright Field; and G. I. F. Theriault (A '32) welding engineer, Frigidaire division, General Motors Corporation.

The following officers were elected for a period of two years:

Directors—E. Herzog (M '29) senior electrical engineer, United States Army Air Corps, Wright Field; A. W. Janowitz (A '11) sales agent, lamp department, General Electric Company; and W. B. Riner (A '34) associate electrical engineer, electrical department, Wright Field.

Speakers Invited to Visit Sections in Western Districts

AIEE Sections in the four geographical Districts of the Institute west of the Missisippi River have expressed an interest in inviting eastern engineers visiting their part of the country to address their Section meetings. Arrangements are being made for the secretaries of these Districts to secure the names of such visitors for transmission to the Sections. Companies with which these engineers making western trips are affiliated are requested to so inform the District secretaries whose names and addresses are as follows:

District 6; F. C. Howard, Iowa–Nebraska Light and Power Company, 144 South 12th St., Lincoln, Nebr.

District 7; R. G. Kloeffler, Kansas State College, Manhattan, Kan.

District 8; M. A. Sawyer, Box 5300, Metropolitan Station, Los Angeles, Calif.

District 9; A. Boyer, Anaconda Copper Mining Company, Butte, Mont.

ABSTRACTS

TECHNICAL PAPERS previewed in this section will be presented at the AIEE national technical meeting, Salt Lake City, Utah, September 2–4, 1943, and are expected to be ready for distribution in advance pamphlet form within the current month. Copies may be obtained by mail from the AIEE order department, 33 West 39th Street, New York 18, N. Y., at prices indicated with the abstract; or at five cents less per copy if purchased at AIEE headquarters or at the meeting registration desk.

Mail orders will be filled
AS PAMPHLETS BECOME AVAILABLE

Air Transportation

43-140—Radio-Noise Elimination in All-Metal Aircraft; *Fred Foulon (M '42). 30 cents.* Aircraft in which the electrical system is not shielded require special consideration to be given their radio circuits. The prevention of noise energy coupling to the receiving lead-in circuits is achieved by adhering to simple radio layout requirements. These requirements incorporate the use of the metal structure as the major shielding element so as to provide the required screening of the lead-in conductors from the local noise fields. The proper noise isolation can always be obtained more economically by such design layout than by entirely shielding the electrical system, as this method requires the use of a great deal of shielding and bonding that produces no useful result. Aircraft radio noise problems are analyzed and a complete noise survey, which requires only simple test methods, is outlined. Methods of correction of existing radio noise, involving the use of additional shielding and filtering, are outlined.

43-145—High-Voltage Ignition-Cable Design for Aircraft; *H. H. Wermine. 15 cents.* Design and operation of high-voltage ignition systems on combat aircraft-engines, together with widely varying climatic conditions in the extensive theaters of war, are factors which have placed unusually severe service demands on high-voltage ignition cable. Cable manufacturers have accordingly accelerated their efforts toward the development of new and improved designs in order to meet these conditions. Consideration is given to the specific conditions under which ignition cable is expected to function during service life. Reasons for unsatisfactory performance of certain types are given also. New materials and designs are contemplated on the basis of performance under service conditions. A departure from the customary cable testing methods is made in the development of simulated-flight testing used to evaluate cable suitability. Close co-operation of the engineers of the air services, engine manufacturers, and cable manufacturers has accelerated the development of new and improved designs and, it is expected, will continue to do so.

43-146—Aircraft Transformers—Small and Light; *O. Kiltie (A '31). 15 cents.* The necessity for light weight and small size in aircraft transformers is very evident, since any reduction in space and weight will reflect larger capacities for fuel and bomb loads. Various types of transformers have been developed recently, such as three-phase to single-phase, single-phase to three-phase, two-phase to three-phase, three-phase to two-phase, combination a-c to d-c transformer-rectifier self-regulated units, miniature instrument type, and a line of general purpose aircraft units with kilovolt-ampere ratings ranging from 100 volt-amperes to 5 kva, with weights ranging from 0.8 pound to 9.5 pounds, and operating at ultimate temperatures of 225 degrees centigrade. Included are vibrator inverter transformers, voltage stabilizers, and high-voltage and low-voltage booster ignition coils.

43-149—Parallel Operation of Airplane Alternators; *D. W. Exner* (*A '42*). *15 cents.* A-c auxiliary power systems are under development for the new large airplanes and, for maximum reliability, parallel operation of alternators must be accomplished. Experience with the two auxiliary-engine-driven 400-cycle plants on the XB-19 airplane is reviewed and conclusions reached on the requirements of a modern system. The problems of driving and paralleling main-engine-driven alternators are discussed and recommendations are made.

Electrical Machinery

43-136—Some Measures of Electrical-Brush Disintegration; *M. S. Coover* (*F '42*), *E. E. Jones* (*A '40*). *15 cents.* In making further explorations into the characteristics of electrical-brush disintegration, a need appeared for the introduction of such concepts as wear resistance, wear resistivity, wear susceptance, and wear susceptibility. The concepts, as developed, are believed to be significant and useful tools that may further an understanding of the basic problems of sliding electrical contacts. For example, they offer means for making a valid comparison of electrical brushes and brush materials insofar as wearing qualities are concerned. Moreover, they provide a clue to the proper consideration and evaluation of the larger number of variables that are engulfed in brush disintegration.

43-137—Turn Ratio of the Capacitor Motor; *T. C. McFarland* (*M '32*). *20 cents.* This paper is an extension of a previous paper entitled "Current Loci for the Capacitor Motor." The effects of changing the turn ratio, based on the assumption that machine constants are unchanged, are discussed. The current loci for different values of turn ratio are determined for a machine of fixed constants, and modifications of suggested rules previously stated are given to account for turn ratio. The effects of turn ratio on certain performance characteristics are demonstrated. A comparison of equal-watt and equal-volt-ampere designs is given.

43-138—Temperature Limits and Measurements for Rating of D-C Machines; *F. A. Compton, Jr.* (*A '39*). *20 cents.* Existing industrial practice for determining temperature rise of d-c machines is based on measurements with thermometers. While experience indicates that such machines have satisfactory service records, tests using resistance measurements disclose the existence of considerably higher internal temperatures than those indicated by thermometer. Greater accuracy and consistency are possible with the resistance method, and it affords a truer indication of winding temperature. It is suggested that the resistance method be used more generally and ultimately recognized in the standards. Detailed recommendations for making temperature measurements by resistance are presented. Correlation of temperature rises determined by resistance and thermometer methods are given on variously ventilated and insulated machines. Suggested values of temperature limits measured by resistance to supplant the now standard thermometer values are presented. The information applies to low voltage (approximately 600 volts maximum) d-c machines with form-wound armature coils and conventional field coils.

Electric Welding

43-139—The Automatic Welding-Machine Starter and Its Relation to Maximum Utilization of Power and Facilities; *N. E. Porter* (*A '43*). *15 cents.* Many electric arc welding applications are of such a nature that the welding machine is running with no load for a large percentage of the operating time. With this low utilization factor or "arc time," no-load power consumption becomes an appreciable item. In plants employing many machines there will be long leads between the machines and the work, either by necessity or for convenience. Under these conditions, the practicability of expecting the operator, or welder, to turn his machine on and off each time he plans to weld is certainly very remote. The automatic welding machine starter has been developed to shut down the machine during the normal no-load running periods. Automatic starters have been in operation under average shipyard welding conditions for the past few months. Application of the automatic starters effects a very appreciable saving in power cost, often 25 per cent or more. In addition a marked reduction in average demand on distribution systems is realized so that additional machines, up to 75 per cent, may be added without further power facilities expenditure.

Industrial Power Applications

43-144—Rectifer Drive for D-C Motors; *K. P. Puchlowski* (*A '43*). *25 cents.* This paper gives a brief outline of the principle of armature voltage control of d-c motors by means of rectifier tubes with controlled angle of ignition. The characteristics and disadvantages of the elementary rectifier-motor system are discussed in some detail. The speed regulation of such a thyratron control system is compared with that of a conventional adjustable voltage drive. Means and circuits for improving speed regulation of a rectifier drive are discussed and results are illustrated with experimental speed-torque characteristics. The problem of automatic acceleration is outlined and current-limit acceleration controlled by means of electronic tubes is discussed. The advantage of a mixed current limit and time-delay acceleration is pointed out and a circuit for automatically controlled acceleration is presented. An outline of the advantages and features of a modern rectifier drive concludes the paper.

43-150-ACO—A New Method of Measuring Contact Bounce; *P. H. Estes.* *15 cents.* In many relay applications, it is essential that the operation of the relay contacts be positive, with mechanical bounce reduced to a minimum. Measurement of bounce is, therefore, an important aid in arriving at the proper design of the contacting mechanism. A simple device for making bounce measurements employs a special recording paper, sensitive to voltage, applied by means of a stylus wire. The contacts being tested are connected to the stylus through an amplifier, so that voltage is applied to the stylus whenever the contacts are together. Bounce, by causing contact separation, removes the potential from the stylus. By moving the paper under the stylus, a broken line, black when the contacts are together and white when they are separated, is obtained. If the paper is moved at a predetermined speed, exact measurement of each bounce may be made in milliseconds. The same device may be used for measurement of operating time, release time, accuracy of repetitive operations, and the effect of residual and eddy currents on operation. It is particularly useful on relays where these values are extremely small.

Instruments and Measurements

43-152—A New Simple Calculator of Load Flow in A-C Networks; *W. E. Enns* (*A '37*). *15 cents.* The paper describes a network calculator of an entirely new form, and of unusually small proportions in its physical size and in the simplicity of its electrical elements. This board may be used to determine the flow of real and reactive power, voltage conditions, losses, and reactive requirements in a-c networks. A single constant voltage supply unit, a-c or d-c, with a multiplicity of voltage taps is used as the power source to the board and eliminates the need of generator and load units. With this design a small number of resistance units may be used to set up completely a complex a-c network consisting of many circuits. Simple network calculators of this type may fill the gap now existing between the use of tedious analytical methods and the complete a-c board for making load-flow studies in a-c networks.

Power System Applications

43-141—Application of 720-Cycle Carrier to Power Distribution Circuits; *J. L. Woodworth* (*Application Pending*). *30 cents.* This paper analyzes the 720-cycle transmission characteristics of 60-cycle power circuits involved in the application of a carrier channel for remote control of street lights, off-peak loads, and other services. Short-line methods generally applicable to urban distribution circuits are developed for predicting the carrier performance from values usually available from 60-cycle distribution studies, such as, conductor size and spacing, load kilovolt-amperes, power factor, and short-circuit kva. The relative advantages of introducing the carrier voltage across, or in series with, the 60-cycle generator, are compared and illustrated. The effects of tap lines and distributed 60-cycle load on the 720-cycle voltage distribution along long lines are considered. Methods of co-ordinating the joint application of power factor correction capacitors and carrier control on the same system are outlined.

Power Transmission and Distribution

43-133—Lightning Surges Transferred from One Circuit to Another Through Transformers; *P. L. Bellaschi (F '40) 25 cents.* Through the medium of transformers surges are transferred from circuits exposed to lightning to circuits considered otherwise nonexposed. The latter may connect to rotating machines, or to industrial apparatus of inherently low impulse insulation level, or to apparatus of old design as a rule even more vulnerable to surges. The surge transferred consists essentially of an electrostatic and an electromagnetic component: the first results from capacitance coupling; the second depends on the turn ratio and short-circuit inductance between windings. Terminal conditions contribute to determine the amplitude, wave form, and duration of the surge transferred. This paper presents the results of an investigation. Simplified methods of calculating transferred surges are derived to assist, in a practical way, those engaged in this type of protective studies. This contribution serves besides to call attention to the vital importance transferred surges may assume under certain conditions.

43-151—The Effects of Mutual Induction Between Parallel Lines on Current Flow to Ground Faults; *J. I. Holbeck (M '36), M. J. Lantz (Application pending). 15 cents.* The paper deals with the effects of mutual induction between parallel transmission lines on current flow to ground faults and discusses methods of solving problems involving mutual induction between transmission lines of the same or different voltages. Diagrams and examples illustrate the effects of mutual induction between paralleling lines on the magnitudes and direction of the ground currents flowing in the lines to a ground fault. Examples are shown demonstrating how improper relaying may occur if the effects of some of the more complicated mutual induction problems are neglected.

Protective Devices

43-142—Dethermalizing Arc Quenchers; *L. F. Hunt (F '38), F. H. Cole (M '42). 15 cents.* This paper describes dethermalizing arc quenchers that cause the arc and its associated space to be cooled by the controlled flow of oil through and around the arc. The first 16-kv breaker was built in 1936. Field tests were made and the results are given in the paper. Later, a new 230-kv breaker was equipped with dethermalizing arc quenchers and field tests were made again. The record of operation of these dethermalizers during the past six years has shown no deterioration of oil, contacts, or insulating materials of the interrupters, and they have cleared all short circuits and line dropping incident to normal operation. From this operating experience, it becomes apparent that this type of arc quencher will result in the very minimum of maintenance and at the same time give a maximum of system protection.

43-143—A New One-Cycle Directional-Overcurrent Relay; *W. C. Morris (A '38). 15 cents.* This paper describes the first successful one-cycle directional-overcurrent relay which incorporates a new principle of memory action in addition to directional control and which is proof against false operation under any practical system operating condition. Directional-overcurrent relays with time delays higher than several cycles have been available for many years, but there is no such relay of the instantaneous type available. Many incorrect relay operations have been traced to the common practice of adding instantaneous attachments to directional-overcurrent relays without realizing the complete lack of co-ordination. Our tests show that an instantaneous plunger relay cannot be co-ordinated with any available directional element, so two induction-cylinder elements were employed. The new feature, "memory," secures a sufficient time delay, of the order of one-half cycle, to give correct performance.

43-148-ACO—Development, Tests, and Operating Record of the Dethermalizer Arc Quencher; *F. H. Cole (M '42), C. P. Garman (M '26). 25 cents.* With the advent of Boulder Dam power in Los Angeles over long-distance transmission lines, a basic need developed for medium and high voltage circuit breakers with shorter interrupting times. Many of the circuit breakers on the United States Bureau of Reclamation's system were of an early design and did not meet this need. Research at River Power Plant led to improvements of the arc quenchers which had operated successfully in circuit breakers on the Bureau's system since 1933. A circuit breaker of an early design was equipped with the improved device and tested in the field at system voltage. Further improvements were made as the tests indicated. Operating experience of 115-kv and 132-kv circuit breakers equipped with arc quenchers of the original and improved types, showing that shorter interrupting times have been realized, is presented.

43-147—A New-Type Carrier Relay Protection; *E. M. Wood (F '43), H. W. Haberl (A '26), and F. A. A. Bailly (A '28). 20 cents.* The paper describes an installation of power line carrier of the single frequency voice-actuated type of which the primary function is for operating communication. On this is superimposed a relaying function for the respective transmission circuit, using tones modulated on the carrier in connection with basic stepped-range directional-impedance line-relay protection. The operation of the instantaneous impedance relaying at either end starts the carrier tone. Transmitted to the other terminal, this is used to by-pass the timer on the second range relay at that terminal, giving, thereby, practically simultaneous clearance of the line for faults at any location in the line. High power (400 watts) is used to assist in transmission of the signal past line faults. The novel features are the combination in one set of the high grade communication with relaying signals and the use of the trip-transfer principle with impedance relaying.

Safety

43-134—Effect of Frequency on Let-Go Currents; *C. F. Dalziel (M '39) Eric Ogden (Enrolled Student), C. E. Abbott. 20 cents.* This paper on electric shock covers the subject of sine wave let-go currents for both men and women, and contains an analysis, based on experiments made on a relatively small number of subjects, which permits improved accuracy in predicting the response for large groups. It should be of especial interest to persons who have had accidents in which they barely escaped "freezing" to an electrified conductor, and also to those interested in electrical safety.

43-135—Effect of Wave Form on Let-Go Currents; *C. F. Dalziel (M '39). 25 cents.* This is a companion paper to the foregoing one, and concludes the study of let-go currents before the experiments were terminated for the duration. This paper extends the analysis to cover various wave shapes including sine waves, direct current, and complex wave forms containing both alternating and direct current components. Conclusions regarding reasonably safe electric currents are based on the criterion that a safe current is the let-go current for $99^1/_2$ per cent of a large group of healthy subjects. These papers are the most comprehensive treatment of the subject yet published as the analysis permits predicting currents of a specified degree of safety for men, women, and children for wave forms likely to be found in practice for a frequency range from 5,000 to 10,000 cycles and direct current.

PERSONAL ● ● ● ●

Stanley Stokes (A '16, F '29) consulting electrical engineer, Union Electric Company of Missouri, St. Louis, has been appointed chief engineer. He was graduated from the University of Missouri with the degree of electrical engineer in 1912 and did construction work for the Mississippi River Power Distributing Company until 1915. In 1915 he became sales engineer for the Electric Company of Missouri predecessor of the Union Electric company. In 1917 he was made assistant vice-president of that company. From 1918 to 1925 he was general superintendent for outlying districts for the Union Electric company. In 1925 he was made assistant vice-president, and consulting engineer in 1935. From 1932 to 1934 he served as AIEE vice-president.

G. P. Gamble (M '36) formerly assistant general superintendent of electrical operations, has been appointed superintendent of production. A graduate of the University of Virginia, he has been associated with the Union Electric company since 1929. He had previously been employed by the General Electric Company, Schenectady, N. Y., and by Stone and Webster, Boston, Mass.

E. L. Hough (A '25, M '38) formerly electrical engineer, has been named chief design engineer. A graduate of the University of North Dakota (1922), he has been with the Union Electric company since 1928. Prior to that he was associated with the General Electric Company at Schenectady, N. Y., and at St. Louis. **C. H. Kraft** (A '17, F '31) formerly superintendent of distribution, has become superintendent of distribution and transmission. He has been with the Union Electric company since 1915 and was made superintendent of distribution in 1925.

William Fondiller (M '15, F '26) electrical apparatus development director, Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed assistant vice-president of the Bell Laboratories. Mr. Fondiller, who was born in Russia in 1885, was graduated from the College of the City of New York with the degree of bachelor of science in 1903. From Columbia University he received the degrees of electrical engineer in 1909, and master of arts in 1913. He entered the engineering department of the Western Electric Company, New York, N. Y., in 1909, engaging in general laboratory work on telephone apparatus. From 1913 to 1923 he was in charge of various experimental groups working on telephone apparatus. In 1923 he was made head of the company's general development laboratory. Since 1925 he has been with Bell Laboratories. He has been a research associate of the engineering department of Columbia University, New York, N. Y., since 1934. The holder of numerous patents and author of several technical papers, he is a fellow of the American Association for the Advancement of Science. **R. G. McCurdy** (A '16, F '34) director of transmission engineering, Bell Telephone Laboratories, Inc., succeeds Mr. Fondiller as director of electrical apparatus development. A graduate of the University of California, Mr. McCurdy was employed in the department of development and research, American Telephone and Telegraph Company, New York, N. Y., from 1916 to 1934. Since 1934 he has been at Bell Laboratories. He is a member of the Acoustical Society of America and Tau Beta Pi.

W. J. Wooldridge (A '06, F '38) manager of electrical sheet sales, Allegheny Ludlum Steel Corporation, Brackenridge, Pa., has retired. Born in Cornwall, England, in 1878, he commenced his electrical career in the testing department, General Electric Company, Schenectady, N. Y., in 1893. He was transferred to the transformer engineering department at Lynn, Mass., in 1895, and in 1898 was placed in charge of the commercial engineering section. In 1903 he was transferred to Pittsfield, Mass. He had charge of electrical sheet manufacture and sales for the Wheeling Steel Company, Portsmouth, Ohio, from 1919 to 1923, and for the Empire Steel Corporation, Mansfield, Ohio, from 1923 to 1934. In 1934 he became manager of electrical sheet sales for the Allegheny company. He is a member of the American Society for Testing Materials, the Iron and Steel Institute, and the British Iron and Steel Institute.

Samuel Ring (A '09, M '28) supervisory engineer, Consolidated Telegraph and Electric Subways Company, New York, N. Y., has retired. He holds the degrees of bachelor of science (1900) and electrical engineer (1915) from Cooper Union. He entered the employ of the New York (N. Y.) Edison Company as tester and foreman in 1905. In 1906 he became assistant general foreman and in 1907 cable inspector. From 1908 to 1911 he was employed on the design and construction of the underground distributing system of the Portland (Oreg.) Railway, Light and Power Company. As statistician he returned to the New York Edison Company in 1911. In succession he became assistant underground superintendent in 1913, general foreman in 1921, assistant engineer in 1923, and division engineer in 1929. In 1940 he was appointed supervisory engineer with the Subways company. He has been active in the various Edison employee associations

W. T. Booth (M '23) engineer in charge of machine switching apparatus design, Bell Telephone Laboratories, New York, N. Y., has retired. He received the degree of bachelor of science from Cooper Union in 1905. From 1900 to 1907 he worked as designer of apparatus for Lambert Schmidt Telephone Manufacturing Company. In 1908 he joined the Western Electric Company, New York, N. Y., where he also worked on apparatus design. From 1911 to 1914 he was attached to the staff of the European engineer at Berlin, Germany, and Antwerp, Belgium. During World War I he served as his company's engineering representative to the Army and Navy. He continued with the Western Electric Company until 1925, when he was given charge of machine switching apparatus design at Bell Laboratories. The duties of repaired apparatus engineer were later added to his work.

F. B. Philbrick (A '20, M '38) formerly Pacific Coast district manager, is now president and general manager of the Gamewell Company, Newton Upper Falls, Mass. A graduate of the Massachusetts Institute of Technology, Mr. Philbrick commenced his engineering career in the testing department of the General Electric Company, Schenectady, N. Y., in 1918. During 1919 and 1920 he was an instructor at the Massachusetts Institute of Technology, Cambridge. He joined the Gamewell Company in 1920 as assistant engineer. In 1924 he became engineer in charge of the drafting room and in 1927 assistant chief engineer. From 1929 to 1937 he was district sales manager of the Pacific Coast states. Since 1937 he has been manager for that district.

M. K. Toeppen (A '21, M '21) formerly principal telephone engineer, Federal Communications Commission, Washington, D. C., has been appointed assistant chief engineer and chief of the common carrier division of the Commission. He has been associated with the Commission since 1931.

R. L. Kaylor (M '36) formerly captain, United States Army, has been promoted to the rank of major and is serving in the South Pacific. He is on leave of absence from Bell Laboratories, Inc., New York, N. Y.

D. J. Maxcy (A '36) formerly junior engineer, Consolidated Edison Company of New York, Inc., is on war leave of absence to work for Sanderson and Porter, Engineers, New York, N. Y.

R. P. Watts (A '38) formerly captain in the United States Army, has been promoted to the rank of major and is director of the Post Engineer Division, Camp Butner, N. C.

J. P. Moran (A '39) formerly tester, Consolidated Edison Company of New York (N. Y.) Inc., has been given a wartime leave of absence to join the Induction Heating Corporation, New York, N. Y.

H. C. Hamilton (A '23, M '26) head of the test and research section, Boston (Mass.) Edison Company, has been elected president of the Engineering Societies of New England.

R. V. Jones (A '20) formerly engineer, American Telephone and Telegraph Company, New York, N. Y., has been commissioned major in the United States Army.

OBITUARY

William James Foster (A '07, F '16) retired consulting engineer, General Electric Company, Schenectady, N. Y., died July 2, 1943. He was born September 17, 1860, at Argyle, N. Y., and was graduated from Williams College with the degree of bachelor of arts in 1884. He received the degree of master of arts from Williams College in 1885 and that of master of science from Cornell University in 1891. He held the doctor of science degree from Cornell

University. From 1886 to 1890 he was teacher of physics and mathematics at the Pottstown (Pa.) High School. In 1891 he entered the Thomson-Houston Company, Lynn, Mass., as a designer. In 1894 he was transferred to Schenectady, N. Y., where he became engineer in charge of electrical design of a-c motors. In 1929 he retired. During his 25 years as design engineer, he took an active part in the design of every important a-c machine built by the General Electric Company. Many of these machines have made outstanding records for long service. He was leader in the development of subdivided conductors to avoid stray losses, the use of radial ventilating systems in turbine alternators, the development of varnished cloth insulation, and the procurement of sinusoidal-voltage wave forms. In 1930 he was awarded the AIEE Lamme Medal, "for contributions to the design of rotating a-c machinery." He served on the AIEE electrical machinery committee from 1920 to 1930, on a special committee on the history of the electrical industry from 1932 to 1934, and on the meetings and papers committee for 1928–29. He was the author of several papers and pamphlets. A member of Phi Beta Kappa, he was a fellow of the American Academy for the Advancement of Science and a member of the Political Science Association.

Claus Marius Bang (A '21) manager, hydroelectric power development, Bowater's Newfoundland Pulp and Paper Mills, Ltd., Corner Brook, died October 14, 1942. Born July 21, 1882, at Copenhagen, Denmark, he received the degree of bachelor of science in mechanical engineering from the Polytechnical Academy, Copenhagen, in 1906. From 1906 to 1910 he was an assistant in the electrotechnical laboratory at the academy. After a year and a half spent on a traveling scholarship in Europe, he joined the Northern Electric and Manufacturing Company, Montreal, Que., in 1911 as a draftsman and engineer. During 1913 he worked as designing draftsman in the electrical department of the Cedars Rapids Power and Manufacturing Company, Montreal. From 1915 to 1918 he was engaged in tool designing and munition plant layout for the Canadian Allis-Chalmers, Rochfield, Que., the Montreal Munition Company, Lachise, Que., the Montreal Tramways Company, and Caran Brothers, Montreal. He was electrical designing engineer with the Wayagamack Pulp and Paper Company, Ltd., Three Rivers, Que., from 1918 to 1924. In rapid succession he worked for the Newfoundland Power and Paper Company, Ltd., Corner Brook, in 1925 and 1926, for the Mistassini Power and Paper Company, Ltd., Montreal, in 1927, and for the Lake St. John Power and Paper Company Ltd., Dolbeau, Que., during 1928 and 1929. From 1930 to 1937 he was electrical superintendent for the Canadian International Paper Company, Three Rivers. In 1938 he became manager of hydroelectric development for the Bowater's company. He was a member of the Danish Society of Civil Engineers.

Louis Christian Marburg (A '02, M '10, F '13) secretary and treasurer, Marburg Brothers, New York, N. Y., died June 26, 1943. Born March 8, 1876, at Wiesbaden, Germany, he attended college at Charlottenburg, Hanover and Darmstadt, Germany. In 1898 he was employed in the drafting room of the Sprague Electric Company, New York, N. Y. He continued with the General Electric Company, Schenectady, N. Y., from 1899 to 1904, as designer of railway motors and power distribution systems. From 1904 to 1910 he was connected with the Bullock Electric Company, Cincinnati, Ohio, and its successor, the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Until 1906 he was concerned chiefly with general railway engineering and power station design. As engineer in the contracting department during 1907 he had charge of all mechanical and electrical engineering undertaken by the department. From 1907 to 1910 he was engineer of the gas and mill engine department. In 1910 he became a partner in the firm of Marburg Brothers. He was a member of the joint conference committee which formed the American Engineering Council, the American Society of Mechanical Engineers, and the Society of Automotive Engineers. He was a past-president (1926) of the Montclair Society of Engineers.

Franz J. Dommerque (A '94, M '96, F '13) consulting engineer, died December 7, 1942, at Bad Godesburg, Germany. Born November 27, 1861, at Duisburg, Germany, he completed the mechanical engineering course at the Polytechnic Institute, Munich. In 1887 he entered the machine shop of Hartmann and Company, Offenbach, Germany, and during 1888 he worked on the construction of power plants for the Schmidt-Douglas Electrical Company, Bradford, England. Coming to the United States in 1888 he entered the employ of the Western Electric Company, Chicago, Ill., as draftsman and designer. From 1889 to 1892 he was associated with the Thomson Electric Welding Company, Lynn, Mass. He was chief draftsman for the Chicago (Ill.) Telephone Company from 1893 to 1900 when he became chief engineer for the Kellogg Switchboard and Supply Company, Chicago. In 1911 he returned to the Western Electric Company, New York, N. Y., and in 1912 was made special telephone engineer for the company in Europe. In 1913 he retired. During 1922 and 1923 he was director of foreign development for the Federal Telephone and Telegraph Company, New York, N. Y.

John Clarence Gaylord (A '11, M '26) superintendent of hydroelectric generation, Southern California Edison Company, Ltd., died June 2, 1943. He was born June 5, 1884, at Clinton, Conn., and received the degree of bachelor of science in electrical engineering from Throop Polytechnic Institute in 1906 and from the Massachusetts Institute of Technology in 1908. As a laboratory and shop assistant he worked for the Southern California Edison company during 1908 and 1909. From 1909 to 1912 he was instructor and assistant professor at the University of Southern California, Los Angeles. He returned to the Southern California Edison company in 1912 as draftsman and station designer. In 1918 he was placed in charge of the electrical division of the engineering department. He became assistant electrical design engineer in 1928 and engineer in the hydro division in 1932. In 1940 he was made superintendent of hydro generation. He was a member of the company's committees on system planning and fire prevention. During 1935–36 he served as Los Angeles Section secretary and as chairman for 1936–37.

Milton Wayne Pollock (M '31) vice-president, Cia. Impulsora de Empresas Electricas, S. A., Mexico City, Mexico, died December 9, 1942. He was born June 2, 1892, at Foosland, Ill., and received the degree of bachelor of science in electrical engineering from Colorado College in 1917. He commenced his career as an electric engineer for the Guanajuato (Mexico) Power and Electric Company from 1920 to 1922. In 1922 he joined the Electric Bond and Share Company, New York, N. Y., as assistant engineer, becoming assistant sponsor engineer in 1925 and sponsor engineer in 1928. From 1929 to 1934 he was chief engineer for the Cia. Hidroelectrica Guanajuatense, S. A., Mexico. As chief engineer he joined the Cia. Impulsora de Empresas Electricas, S. A., in 1934 and in 1940 became vice-president. He was chairman of the AIEE Mexico Section for 1934–35. During World War I he served as a captain in the coast artillery.

Barrett Morris Merrill (A '17, F '28) manager of power supply, Washington Water Power Company, Spokane, died June 15, 1943. He was born at Syracuse, N. Y., April 21, 1880, and was graduated from Purdue University with a bachelor of science degree in electrical engineering in 1902. From 1902 to 1905 he worked for the Puget Sound Electric Railroad Company, Seattle, Wash., as substation operator and superintendent of electrical properties. Since 1905, when he was employed as assistant superintendent of light and power in charge of transmission, he had been with the Washington Power company. In 1910 he was made assistant superintendent in charge of power, and in 1918 superintendent of power. He became superintendent of light and power in 1928. In 1940 he was appointed manager of power supply.

Fred J. McCormick (M '37) plant protection engineer, Wisconsin Telephone Company, Milwaukee, died in November 1942. He was born May 28, 1882, in Waukeoka County, Wis. He entered the employ of the Wisconsin Telephone Company in 1899. Until 1913 his various assignments brought him into contact with operation, construction, maintenance, and management of telephone systems. From 1913 to 1920 he designed toll and exchange plants and was company representative in foreign wire relations. In 1920 he was made toll construction engineer and in 1932 plant protection engineer. As such he specialized in foreign wire relation problems.

James William Perry (A '03, M '13) retired vice-president, Johns-Manville, Inc., New York, N. Y., died March 9, 1943, at Monterey, Calif. Born at Parkersburg, W. Va., March 18, 1868, he began his association with the Johns-Manville company as a salesman for its predecessor, the H. W. Johns Manufacturing Company, Philadelphia, Pa., in 1888. In 1893 he became manager of the electrical department and as such was transferred to the New York office of the Johns-Manville company. In 1925 he was appointed vice-president and retired in 1929.

Roger Cleveland Newberry (A '39) lieutenant in the United States Army has been killed in action. Born July 16, 1916, at Cleveland, Ohio, he was graduated from Yale University in 1938 with the degree of bachelor of engineering. He was employed in the service department of the Otis Elevator Company, Youngstown, Ohio, from 1938 to 1941 as junior salesman and service and maintenance man. In 1942 he became an air cadet in the Army.

MEMBERSHIP • •

Recommended for Transfer

The board of examiners, at its meeting on July 22, 1943, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Albright, A. S., acting chief of research, Detroit Edison Co., Detroit, Mich.
Balch, E. C., chief engr., Michigan Bell Telephone Co., Detroit, Mich.
Chase, P. H., chief engr., Philadelphia Electric Co., Philadelphia, Pa.
Higbie, H. H., prof. of elec. engg., University of Michigan, Ann Arbor, Mich.
Langstaff, H. A. P., elec. engr., West Penn Power Co., Pittsburgh, Pa.
Miller, W. C., supt. of elec. system, Detroit Edison Co., Detroit, Mich.
Moore, A. D., prof. of elec. engg., University of Michigan, Ann Arbor, Mich.
Wagner, H. H., chief electrical engr., Pennsylvania Transformer Co., Pittsburgh, Pa.

To Grade of Member

Alter, J. M., lead inspector, Test Dept., Pennsylvania Railroad, Altoona, Pa.
Armstrong, H. R., test engr., Detroit Edison Co., Detroit, Mich.
Barcus, E. D., engr., Southern California Telephone Co., Los Angeles, Calif.
Bary, C., rate research engr., Philadelphia Electric Co., Philadelphia, Pa.
Bell, B. H., operating electrical engr., New Orleans Public Service Inc., New Orleans, La.
Boast, W. B., asst. prof., Iowa State College, Ames, Iowa.
Boice, W. K., elec. engr., General Electric Co., Schenectady, N. Y.
Brauer, H. H., senior engr., Stromberg-Carlson Co., Rochester, N. Y.
Cheverton, J. A., station engr., Wisconsin Electric Power Co., Milwaukee, Wis.
Christensen, J. F., asst. elec. engr., Aqua Systems, Inc., New York, N. Y.
Gakle, W. F., chief engr., Kuhlman Elec. Co., Bay City, Mich.
Holliday, T. B., Lt. Col., U. S. Army Air Forces, Wright Field, Dayton, Ohio.
Hughes, G. N., elec. engr., Aluminum Co. of America, Alcoa, Tenn.
Jeynes, P. H., depreciation engr., Public Service Elec. & Gas Co., Newark, N. J.
Johnson, J. S., asst. prof. of elec. engg., Missouri School of Mines and Metallurgy, Rolla, Mo.
Livingston, O. W., elec. engr., General Electric Co., Schenectady, N. Y.
Maddrey, W. D., division engr., Texas Electric Service Co., Eastland, Texas.
Mathes, K. N., elec. engr., General Electric Co., Schenectady, N. Y.
Matthewson, D. E., asst. engr., Prudential Insurance Co., Newark, N. J.
McCarty, O. P., elec. engr., General Electric Co., Pittsfield, Mass.
Nelson, O. L., engr., Southern California Telephone Co., Los Angeles, Calif.
Northrop, B. K., associate prof. of elec. engg., Cornell University, Ithaca, N. Y.
Ramo, S., electronics engr., General Electric Co., Schenectady, N. Y.
Ries, C. F., asst. to supt. of substation, Detroit Edison Co., Detroit, Mich.
Robnett, V. P., Lt. Comdr., USNR, U. S. Naval Academy, Annapolis, Md.
Sage, R. S., engr., General Elec. Co., Schenectady, N. Y.
Sayres, D. B., switchgear circuit designer, General Elec. Co., Philadelphia, Pa.
Schmidt, M. L., section engr., General Electric Co., Fort Wayne, Ind.
Sheldon, E. E., senior engr., General Electric Co., Bridgeport, Conn.
Stevens, R. F., Lieut., Civil Engineer Corps, USNR, Denver, Colo.
Tulloch, D. F., asst. head of distribution, Boston Edison Co., Boston, Mass.
Vassil, P. N., Capt., Signal Center Teams, CSCS, Camp Crowder, Mo.
Vikoren, O. B., engr., Philadelphia Electric Co., Philadelphia, Pa.
Walker, D. S., chief engr., Industrial Scientific Corp., New York, N. Y.
Ware, L. A., associate prof. of elec. engg., University of Iowa, Iowa City, Iowa.
Way, K. J., telephone engr., U. S. War Dept., Fort Monmouth, N. J.
Westrate, M. C., elec. engg. dept., Commonwealth & Southern Corp., Jackson, Mich.

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. Any member objecting to the election of any of these candidates should so inform the national secretary before August 31, 1943, or October 31, 1943, if the applicant resides outside of the United States or Canada.

To Grade of Member

Belt, T. A. E. (Re-election), Hercules Powder Co., Lawrence, Kans.
Brown, E. H. (Re-election), Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Cochrane, H. H. (Re-election), Montana Power Co., Butte, Mont.
Dupuis, R., Universite Laval, Quebec, Que., Can.
Fleming, R. A., Major R.C.O.C., Ottawa, Ont., Can.
Griswold, L., Gen. Elec. Co., Phoenix, Ariz.
Hatch, T. E., Liquid Cooled Eng. Div., Toledo, Ohio.
Hogan, J. P., Post Engr. Office, Camp Tyson, Tenn.
Hoot, D. W. (Re-election), Nicaro Nickel Co., New York, N. Y.
Nygren, E. F., Boeing Aircraft Co., Seattle, Wash.
Pemberton, H. L., Alum. Co. of Canada, Ltd., Montreal, Que., Can.
Shelton, F. H., Empire Dist. El. Co., Joplin, Miss.
Simm, S. G. (Re-election), U.S.C.G. Hq., Washington, D. C.
Smith, M. W., Gibbs & Hill, Inc., Pittsburgh, Pa.
Sorensen, E. M., Sorensen & Co., Inc., Stamford, Conn.

To Grade of Associate

United States and Canada

1. NORTH EASTERN

Bridgett, A. W., U. S. War Dept., Boston, Mass.
DeLucia, V. E., Machlett Labs., Inc., Norwalk Conn.
Foster, C. M., Chas. T. Main, Inc., Boston, Mass.
Hedtler, P. A., Dewey & Almy Chemical Co., Cambridge, Mass.
Mulkins, C. G., Central N. Y. Pr. Corp., Syracuse, N. Y.
Phelps, B. E., Int. Bus. Mch. Corp., Endicott, N. Y.
Thomas, H. E., West. Elec. & Mfg. Co., Boston, Mass.
Woodworth, J. L., Gen. Elec. Co., Schenectady, N. Y.

2. MIDDLE EASTERN

Farrow, C., Republ. Steel Corp., Cleveland, O.
Glass, R. A., Carnegie Ill. Steel Co., Youngstown, Ohio.
Hart, F. G., Cramp Shipbuilding Co., Philadelphia, Pa.
Linsenmeyer, J. Z., West. Elec. & Mfg. Co., East Pittsburgh, Pa.
Mullen, C. E., Duquesne Light Co., Pittsburgh, Pa.
Reifschneider, P. J., Gen. Elec. Co., Philadelphia, Pa.
Ricketts, R. E., Aircraft Radio Laboratories, Dayton, Ohio.
Suomi, N. A., May-Fran Engr. Inc., Cleveland, O.
Weadon, R., Kaiser Cargo, Inc., Bristol, Pa.

3. NEW YORK CITY

Caruso, C. G., Watson-Flagg Engg. Co., New York, N. Y.
Lange, R. C., Gibbs & Cox, New York, N. Y.
Lindstrom, P. J., Staten Island Edison Corp., Staten Island, N. Y.
Oliver, J. W., Jr., U. S. Army, Fort Monmouth, N. J.
Shieh, P. H., Nat. Res. Co. of Chinesse Gov., New York, N. Y.
Taffett, M. S., Radio Tel. Inst., New York, N. Y.

4. SOUTHERN

Jones, C. C., U. S. Army, Camp Wheeler, Ga.
Murphy, A. L. (Re-election), 3836 Central Ave., St. Petersburg, Fla.
Peet, H. D., Curtiss-Wright, Corp., Louisville, Ky.
Temple, C. V., T.V.A., Chattanooga, Tenn.
White, R. M., Higgins Ind., Inc., New Orleans, La.

5. GREAT LAKES

Amundson, R. H., Line Material Co., South Milwaukee, Wis.
Chick, S. G. (Re-election), Ford Motor Car Co., Willow Run, Mich.
Hardisty, T. W., U. S. Navy, Milwaukee, Wis.
Herziger, W. J., Allis-Chalmers Mfg. Co., West Allis, Wis.
Ison, L. M., Pub. Serv. Co. of Ind., Indianapolis, Ind.
Jaeschke, R. L., Dynamatic Corp., Kenosha, Wis.
Rogers, E., Pub. Serv. Co. of North. Ill., Waukegan, Ill.
Stomberg, V., Gen. Elec. Co., Ft. Wayne, Ind.
Swenson, C. P., James Stewarts Co. Inc., Chicago, Ill.
Timm, H. D., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Wood, C. O. (Re-election), Goodman Mfg. Co., Chicago, Ill.
Zambreno, R., U. S. Maritime Comm., Chicago, Ill.

7. SOUTH WEST

Tarpley, J. W., U. S. Navy, Austin, Texas.

8. PACIFIC

DeConly, J. C., Holmes & Narver, Cons. Engrs., Los Angeles, Calif.
Hutchison, E. G., Jr., U. S. Navy, Los Angeles, Calif.
Miller, F. A., Douglas Aircraft Co., Santa Monica, Calif.
Nipper, A. H., Capitol El. Co., San Diego, Calif.
Shuey, R. L., U.S.N.R., Pacific Fleet, San Francisco, Calif.
Smith, L. S., U. S. Navy Yard, Mare Island, Calif.
Wolff, T. L., Southern Pac. Co., San Francisco, Calif.

9. NORTH WEST

Bruce, W. F., U. S. Navy, Spokane, Wash.
Edgecomb, H. C. (Re-election), Boeing Aircraft Co., Seattle, Wash.
Franzen, R. J., Graybar Elec. Co., Ltd., Seattle, Wash.
Hansen, V. (Re-election), War Prod. Board, Portland, Oreg.
Kirk, C. H., Mont. Power Co., Butte, Mont.
Pelles, J. S., Jr., Army Air Base, Great Falls, Mont.
Sayner, W. V., Signal Corps, U. S. Army, Seattle, Wash.

10. CANADA

Davison, J. L., Alum. Co. of Can., Ltd., Montreal, Que., Can.
Hyatt, F. E., Alum. Co. of Can., Ltd., Montreal, Que., Can.
King, A. L., Ferranti Elec. Ltd., Mt. Dennis, Ont., Can.
Laurence, J., École Polytechnique, Montreal, Que., Can.
Smith, E. G., Alum. Co. of Canada, Ltd., Montreal, Que., Can.
Thomson, J. A., Alum. Co. of Canada, Ltd., Montreal, Que., Can.
Walton, E. N., Philips Elec. Works, Ltd., Montreal, Que., Can.

Elsewhere

Hodgkinson, W. A., Ferranti, Ltd., Chadderton, England.

Total to grade of Associate
United States and Canada 62
Elsewhere, 1

OF CURRENT INTEREST

Inventors Council Seeks Solution to Military Problems

The National Inventors Council is soliciting suggestions leading to the solution of problems which have been posed to our armed forces by actual field operations. War conditions have demonstrated the need of various devices or methods not practically available and have shown the desirability of substitutes or alternatives for devices and methods already in our possession. Additional lists of current military needs may follow this present one. The list recently released by the Council includes:

1. A method of removing the tetraethyl lead from leaded gasoline to make it usable in stoves, lanterns, and small engines.
2. An inexpensive metal suitable for Quartermaster tableware with requisite strength, freedom from corrosion by food acids or alkalis, durability, and attractiveness.
3. Suitable substitute for rubber for insulating wire that is flexible and durable.
4. Detectors of enemy personnel, who may be approaching unseen, on jungle trails or fences or similar barriers.
5. Sonic or supersonic means or methods of signaling in the field.
6. Improved means or methods of signaling the identification of ground troops to friendly airplanes and vice versa.
7. Improved traction devices for wheeled vehicles of all types. (Present chains and other devices are cumbersome, inconvenient to apply and remove, and lack sufficient traction.)
8. Tracks for tractors and other motorized equipment which will operate efficiently in snow and extreme cold.
9. Better air cleaners for use on tank engines and the like which are more effective than present cleaners and require less maintenance.
10. Methods of quick-action waterproofing for enabling vehicles to ford water several feet deep, without stalling engines.
11. Storage battery not adversely affected by very low temperatures.
12. The detector and method of locating nonmetallic land mines.
13. Equipment or methods for removing land mine rapidly from mine fields without injury to equipments or personnel.
14. Methods of rustproofing ferrous metals, which are more durable than present methods, such as bonderizing.
15. Absorbents for carbon monoxide, or catalysts, or other means for oxidation of this gas to render it noninjurious to personnel.
16. Means of defeating darkness to permit vision at night without aid of visible reflected light. (Probably involves an apparatus to translate infrared rays to visible light.)
17. Means of long-distance communication outside the present scope of radio and not restricted by line-of-sight projection.
18. Searchlights which may afford ready means for spreading the beam from narrow high intensity to 15 degrees of greatest intensity practicable.
19. A simple nontoxic process for darkening aluminum and other metals to make them nonreflectant to light.
20. Methods of sabotage by friendly inhabitants within occupied areas.

Suggestions should be submitted to the National Inventors Council, Room 1313, Commerce Building, Washington, D. C., and should comprise a clear description of the proposal with such sketches or drawings as may be necessary.

Fees for Licenses Under Enemy Patents Lowered

The steadily growing demand for licenses under patents seized from enemy and enemy-occupied countries, has led to the reduction of the fee for obtaining such licenses, Alien Property Custodian Leo T. Crowley announced recently. Effective August 1, 1943, the fee will be a flat \$15 for each patent instead of \$50 for the first patent license and an additional \$5 for each related patent.

Advantages to the new terms are that small manufacturers can put single patents to work more promptly, and procedures necessary to release the patents will be simplified since it will no longer be necessary to devote time to determining whether several patents covered by a single application are in a related field. The new fees are also a more equitable compensation for the work involved in searching out contractual agreements that already exist on specific patents.

For more details on the procedure for securing foreign patent licenses see *Electrical Engineering*, June 1943, page 277.

New 30,000-Kw Plant Completed at Fort Peck Dam, Montana

The major part of the power produced at the 30,000-kw-capacity power plant, recently completed by the Corps of Engineers, at Fort Peck Dam, Mont., will be distributed by the Bureau of Reclamation to war industries in Montana and Utah, according to an announcement by Secretary of the Interior Harold I. Ickes.

With the addition of power from the Fort Peck Dam to its system, the Bureau of Reclamation now distributes power from 31 plants with an installed capacity of 1,875,000 kw. The plant at Fort Peck Dam will take an important place in the

Complex Wiring Installed in Radar Sets

These assemblers are installing the intricate wiring in radar sets destined for the use of the United States Navy. The sets are being built at the General Electric Company, Schenectady, N. Y., by men and women who formerly made broadcasting-station transmitters and home receivers, as well as by many thousands of newly trained workers

development of the mineral resources of Utah and Montana for war needs, as practically all of the power developed in these two states is hydroelectric.

JOINT ACTIVITIES

Shock Testing Standard Issued. The American War Standard, "Shock Testing Mechanism for Electrical Indicating Instruments," has recently been released by the American Standards Association. Designed at the request of the War Production Board, with the aid of representatives of industry and the armed services, the mechanism will determine the suitability of delicate electrical indicating instruments for use in mobile and field communications equipment, and other apparatus subject to severe shock. Copies of the new standard are available at ASA headquarters, 29 West 39th Street, New York 18, N. Y., at 25 cents each.

OTHER SOCIETIES •

IES Plans Enlarged Postwar Program

On recommendation of its committee on postwar planning, the Illuminating Engineering Society has scheduled two changes in its postwar organization. After the war, a technical secretary, with the general duty of stimulating and facilitating the various technical and research projects carried on under the society's sponsorship, will be employed on a full-time basis. He will work under the executive secretary at headquarters. The IES is also planning publication of a lighting handbook which will include the solutions of specific problems in industrial and commercial lighting, as well as the discussion of the general principles of illumination design and methods of calculation. The publication will be under the supervision of a publication committee headed by S. B. Williams (M '37) editor, *Electrical World*, New York, N. Y.

The IES committee on postwar planning is composed of: Ward Harrison (F '36), General Electric Company, Cleveland, Ohio, *chairman;* G. K. Hardacre, Public Service Company of Northern Illinois, Chicago; R. M. Staud, Benjamin Electric Manufacturing Company, Des Plaines, Ill.; E. M. Strong (M '40), Cornell University, Ithaca, N. Y.; and S. B. Williams.

Dudley Medal Awarded; ASTM Officers Announced

Walter Bonsack, chief metallurgist and director of research laboratories, National Smelting Company, was awarded the Charles Dudley medal for 1943 for his paper, "Discussion of the Effect of Minor Alloying Elements on Aluminum Casting Alloys," at the 46th annual meeting of the American Society for Testing Materials held June 28 to July 2, in Pittsburgh, Pa. The medal is awarded annually, in commemoration of the society's first president, for a technical paper of outstanding merit which represents a contribution of original research.

The new officers introduced at the meeting were:

President: Dean Harvey, materials engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Vice-president: J. R. Townsend, materials standards engineer, Bell Telephone Laboratories, Inc., New York, N. Y.

Members of the executive committee: T. A. Boyd, head of the fuel department, General Motors Corporation, Detroit, Mich.; W. H. Finkeldev, Singmaster and Breyer, New York, N. Y.; E. W. McMullen, director of research, Eagle-Picher Lead Company, Cincinnati, Ohio; E. O. Rhodes, technical director, tar and chemical division, Koppers Company; and F. G. Tatnall, manager, testing equipment department, Baldwin Locomotive Works.

Future Meetings of Other Societies

American Chemical Society. September 6–10, 1943, Minneapolis, Minn.

American Institute of Mining and Metallurgical Engineers. Joint fuels conference, October 28–29, 1943, Pittsburgh, Pa. Annual meeting, February 20–24, 1944, New York, N. Y.

American Society for Metals. Annual convention, October 18–22, 1943, Chicago, Ill.

American Society of Mechanical Engineers. Annual Meeting, November 29–December 3, 1943, New York, N. Y.

American Welding Society. 24th annual meeting, week of October 18, 1943, Chicago, Ill.

Association of Iron and Steel Engineers. Annual meeting, September 28–30, 1943, Pittsburgh, Pa.

National Electrical Manufacturers Association. October 25–29, 1943, New York, N. Y.

National Safety Congress and Exposition, October 5–7, 1943, Chicago, Ill.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Kilgore Bill

To the Editor:

Undoubtedly you are familiar with the Kilgore bill (S.702) now pending in the United States Senate. This bill particularly affects all technical men, and I am therefore surprised that no mention of it has been made in *Electrical Engineering*.

Briefly, the bill authorizes the complete socialization of all forms of property, plans, methods and technical information of all industries and all personnel devoted to scientific and technical effort. Under this bill the government could control all scientific and technical personnel, including all persons except physicians and dentists, who have completed college or university studies in any branch of science, or have at least six months training or employment in a technical vocation.

Under this bill the government could acquire exclusive rights in inventions to which the government shall contribute any money, physical facilities, or personnel. This, of course, ignores the constitutional rights of inventors.

All, of course, know that the progress of our country has been due in large part to industrial research and development work. In my opinion the Kilgore bill effectively throttles such work through the removal of any incentive to pioneer new developments.

Finally, we members of technical societies are directly affected since the National Roster of Scientific and Specialized Personnel, to which our names have been furnished by the various societies, could serve as a starting point in socializing technical personnel. We are all glad to do our part in aiding the war effort, which was the reason for establishing such a roster. However, the Kilgore bill is not limited to the length of the war, but specifically provides for the socialization of industry in peacetime.

I believe that the provisions of the Kilgore bill would ultimately cause the disaster of our country. I further believe that it is the duty of the various technical societies as such and their members as individuals to do everything in their power to defeat this bill.

C. M. HINES (A '41)

(Electrical engineer, Westinghouse Airbrake Company, Wilmerding, Pa.)

Editor's Note: The AIEE board of directors recently took action opposing passage of both the Kilgore bill and its House of Representatives counterpart, the Patman bill H.R. 2100. See item in "Institute Activities" section, this issue.

NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

America's Greatest Inventors. By J. C. Patterson. Thomas Y. Crowell Company, New York, N. Y., 1943. 240 pages, diagrams, $8^1/_2$ by $5^1/_2$ inches, cloth, $2. (ESL.)

This book tells briefly the lives and inventions of the 18 men who were selected as America's greatest inventors in connection with the celebration, in 1940, of the sesquicentennial of the United States patent law. The list is an impressive one. The biographies are interesting, accurate, and popular in style.

Analysis of Continuous Frames by Graphical Distribution of Moments. By A. A. Eremin. Apply to author and publisher, A. A. Eremin, 1541—37th Street, Sacramento, Calif., 1943. 17 pages, diagrams, etc., 11 by $8^1/_2$ inches, paper, $2. (ESL.)

This pamphlet presents a graphical method for the distribution of moments in continuous beams or rigid frames. The method is held to be as exact as algebraic methods and to be much less time consuming. Numerous illustrative examples are given.

ASTM Standards on Plastics. By ASTM committee *D*-20 on plastics; specifications, methods of testing, nomenclature, definitions. American Society for Testing Materials, Philadelphia, Pa., 1943. 375 pages, illustrations, etc., 9 by 6 inches, paper, $2. (ASTM members, $1.50). (ESL.)

The specifications, methods of test, recommended practices, nomenclature, and definitions relating to plastics which have been approved by the society are brought together in one volume for convenience.

Basic Electricity for Communications. By W. H. Timbie. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1943. 603 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, cloth, $3.50. (ESL.)

This is an introductory text for workers in communications and electronics. The book presents the elementary electrical principles that are needed in those fields and applies the principles to concrete practical problems that occur frequently. The text is intended as a course for workers and also as a foundation for advanced study.

Engineering Drawing. By I. N. Carter and H. L. Thompson. 2nd edition. International Textbook Company, Scranton, Pa., 1943. 462 pages, illustrations, etc., 11 by $8^1/_2$ inches, fabrikoid, $3. (ESL.)

Descriptive geometry and practical engineering drawing are combined in this text. Thus theory and practice are presented simultaneously. Duplication of classroom work is avoided, thus enabling the student to save time.

Engineering Problems Illustrating Mathematics. By J. W. Cell. McGraw-Hill Book Company, New York, N. Y., and London, England, 1943. 172 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $1.75. (ESL.)

This text contains a collection of problems for students of college algebra, trigonometry, analytical geometry, and differential and integral calculus. It is intended for use in junior and senior engineering courses. By presenting practical problems of technological and industrial application, it aims to give students better understanding of the uses of mathematics than they usually obtain from purely formal exercises. The work is a project of the Society for the Promotion of Engineering Education.

Heating, Ventilating, Air Conditioning Guide, Volume 21. American Society of Heating and Ventilating Engineers, New York, N. Y., 1943. 1160 pages + roll of membership, illustrations, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $5. (ESL.)

The 1943 edition of this well-known reference book follows the form of preceding ones but has been revised carefully and, in part, rewritten. A chapter on abbreviations, symbols, and standards has been added, and an appendix describes emergency war practices now in use.

Introduction to Atomic Physics. By S. Tolansky with a foreword by Sir L. Bragg. Longmans, Green and Company, London, England, New York, N. Y., and Toronto, Ont., 1942. 343 pages, illustrations, etc., 9 by $5^1/_2$ inches, cloth, $4.50. (ESL.)

The aim in this book is to supply a broad survey of the development of modern atomic physics for students who have completed a first year of college physics and are proceeding further. The treatment is descriptive and calls for little mathematical knowledge.

Mathematics of Physics and Chemistry. By H. Margenau and G. M. Murphy. D. Van Nostrand Company, New York, N. Y., 1943. 581 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $6.50. (ESL.)

This book brings together, within a single volume, those parts of advanced mathematics that form the tools of the modern worker in theoretical physics and chemistry. The subjects selected for treatment are those believed to be the most important for such workers, and the subject treatment is full enough for practical purposes.

Principles and Practice of Radio Servicing. By H. J. Hicks. 2nd edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1943. 391 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $3.50. (ESL.)

This textbook explains the fundamental principles of radio and discusses their application to the various components of radio receivers. Definite instructions are then given for performing all the more complicated servicing procedures. Test equipment is discussed at length. The new edition has been thoroughly revised.

Rise of the Electrical Industry During the Nineteenth Century. By M. MacLaren. Princeton (N. J.) University Press, 1943. 225 pages, illustrations, $9^1/_2$ by 6 inches, cloth, $3.75. (ESL.)

This volume presents an interesting, useful, and general account of the early development of all of the principal branches of electrical engineering. The story is told in nontechnical form, but an extensive bibliography is provided for further study. The author, as an engineer actively connected with many electrical developments and as a teacher, writes with first-hand knowledge of much of his field. Pictures of many historic pieces of apparatus are included.

Symposium on Radiography. American Society for Testing Materials, Philadelphia, Pa., 1943. 256 pages, illustrations, etc., 9 by 6 inches, cloth, $4. (to ASTM members, $3.). (ESL.)

This book contains 13 papers presented at a symposium held by the Society in 1943 and re-edited copies of five papers presented at its 1936 symposium. The papers deal with the principles of radiography, various applications to production problems and testing, portable radiographic apparatus, and other practical matters.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Recent Price Interpretations Number 23. Price Legal Co-ordination Branch, Office of Price Administration, Washington, D. C., 1943. 22 pages; persons will be placed upon mailing list upon request.

Operating Guide for Single Retort Stokers. Department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., 1943. 42 pages.

Typical Electric Bills, Cities of 50,000 Population and More. Federal Power Commission, Washington, D. C., 1943. 41 pages, 10 cents.

Spreading the Work. Smaller War Plants Corporation, H. O. L. C. Building, 1st and Indiana Avenue, Washington, D. C., 1943.

Manpower. Research Institute of America, 292 Madison Avenue, New York, N. Y., 1943. 92 pages.

Radiant Heat Drying Lamps. Westinghouse Lamp Division, Bloomfield, N. J., 1943. 12 pages.